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THE AMERICAN
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VOL. 104 SEPTEMBER, 1932 NO. 9

EDITORIALS

THE FIRST MORPHINE*

TO THE traveler in the province of Hanover in Prussia, who is fortunate to come upon the quaint little settlement of Einbeck, is pointed out the spot where not so many years ago an inquisitive apothecary unravelled the mysteries of opium and gave to the world morphine, first of all the alkaloids. The apothecary, Friedrich Sertürner, so we are told, was not an overlearned man. He could write after his name no trail of dignified capitals, and his training in science had come to him not because it was forced upon him, but rather because he had yearned and struggled for it. His Gamaliel was Experiment and his University Experience. And yet, "unlettered, unsponsored and unread," he "opened the way to a vast domain of medical discoveries." Situate on a corner where alley met main street, this famous apothecary shop but looked the counterpart of scores of similar "concessioned" establishments in that province of Germany. Unpretentious and perhaps meager stocked but smiling with cleanliness and beaming the story of Frau Sertürner's neat custodianship, the little shop catered to the drugstore wants of a stolid community.

Out of Einbeck no one knew or cared to know what went on inside its walls, and the townsfolk themselves cared but little so long as they could promptly get their herbs and simples when they needed them.

But somewhere back of the overvarnished and grotesquely carved partition the apothecary himself might be seen, early in the morning and very late at night, working by the fitful light of a malodorous whale oil lamp, puttering with muddy extracts and decoctions of strange Asiatic drugs. Crude was his equipment and meager his

*Part of an article written some ten years ago by the editor and here combined with one of *Science News*—"Classics of Science."

apparatus, but he worked on incessantly. He worked on and on until the gossipy red-nosed men that lounged at the inn-front across the alley began to whisper forebodings of disaster to his well-established business. Frau Hohenlohe, an over-friendly neighbor, confided to Hausfrau Sertürner, as only women can, that the good *apotheker* was in danger of losing his concession unless he quit "playing with experiments" and tended better to business, for had he not one day kept the Colonel of Hussars waiting a half hour for a draught of *braus-pulver* while he, the *apotheker,* mussed about in inky vials of vile imported drugs torturing them with fire to seek their essence.

And so it was that the good housewife cautioned her partner to mend his ways and secured from him a promise, readily granted and as readily broken. For the next morn, so the story goes, before the sun had rubbed the cloudlets from its eyes, Sertürner was again at his beloved experiments seeking from the crude and dirty opium the essence that gave it its soothing virtues. A tinkling of heavy glassware, the bubbling of boiling extracts and the thumping of pestle in mortar broke harshly on the peaceful reveries of the morning hours and the half-awakened village blacksmith on his way to labor pointed in wonderment to the light in the dormered window of the *apotheke* shop, for here was a man who could but would not sleep even in the morning when sleep is sweetest. But the blacksmith little knew that the light of that dormered window would shine on into everlasting centuries and that the pathway of science would be greatly brightened by its penetrating beams.

For on that same morning borrowing a leaf from the book of the mathematical Greek, Sertürner aroused the neighbors with his joyous cries of *Eureka! Eureka!* and the discovery of morphine, long searched for by many and many a chemist, had become a fact.

Shortly afterwards (1806) Sertürner announced his discovery of *"opium-saure,"* later called meconic acid, and explained how it was combined in the drug with an alkaline base, which he called *"morphium."*

His report amazed the scientific world of that day and its importance was fully recognized when France later awarded to him a substantial monetary prize for "having opened the way to important medical discoveries by his isolation of morphine and his exposition of its character."

Thus it was that out of the modest apothecary shop in Einbeck of Hanover, came the story of the first alkaloid, the herald of an

unending trail of like substances that have been since made known and utilized to the benefit of mankind. Sertürner had certainly "opened the way," and no better compliment than this can be paid to any worker in the ranks of science.

"Morphine

But let Sertürner speak for himself—as interpreted in *Science News*—"Classics of Science—The First Morphine."

"Eight ounces of dried opium was repeatedly digested with small amounts of hot distilled water, until this was no longer colored by it. The various washings after evaporation gave a clear extract, which upon dilution with water became very turbid, and only regained its transparency through the help of warming or a greater amount of water.

"The extract diluted with water was saturated with ammonia while still warm, whereupon a grayish-white material precipitated, which however soon for the most part took on crystalline form, and displayed transparent grains. These, repeatedly washed with water until they no longer color it, are, as the following part of this investigation shows, the true, active principle of opium, morphine, but still mixed with extractive material and meconic acid.

"When dried the material obtained from the clear little crystals weighed 16 drachms. It was treated with dilute sulphuric acid until slightly supersaturated, and from this solution precipitated anew by ammonia, and then repeatedly digested with dilute ammonia, with the intention of thus separating it from accompanying extractive materials. But this could not be entirely accomplished in this way, so I pulverized the precipitate to a fine dust, and digested it several times with very little alcohol, which became very dark in color. In this way I obtained about 8 drachms of nearly colorless morphine.

"The morphine which dissolved in this alcohol was recovered by crystallization, but was of no importance. The extracted material which was found with it in the alcohol, as well as in the ammoniacal extraction, was not the pure extract, but a basic morphine-extract, easily soluble in acids, dissolved with difficulty in water but easily in alcohol, and this extracted material the salts of iron color green. At the same time, however, morphine can be obtained from it when decomposed and a part separates as the oxide. Pure morphine is obtained from solution in acid as a fine glistening powder, and its true

crystal form, a parallelopiped with oblique sides, which appears to be that of the extractive material which is combined with morphine, changes its characteristic shape to almost cubical grains. This change was brought about by treatment of this material with ammonia. It dissolved a part of the extractive material, which has the nature of an acid, though always combined with morphine and not able to be separated from it. Alcohol completed the separation, and dissolved the remaining extractive material in combination with morphine. There is a striking difference between the behavior of extracts with ammonia and those with alcohol. The first is more easily soluble in water, because it contains less morphine, than the brown substance obtained with alcohol; in the latter the extractive material predominates in which morphine occurs. And from this, through a solution of morphine in alcohol, that change comes about in the last resinous bodies in which morphine takes the lead and, as it were, exhibits a basic combination. The water extract of opium in the concentrated state is always broken up by ammonia into these two compounds.

"The morphine so treated I dissolved again in alcohol, in order to get it quite pure, and let it crystallize, by which I obtained it quite colorless and beautifully crystallized in perfectly regular horizontal parallelopipeds with oblique sides. The crystallizable material obtained according to Derosne by extraction of opium with alcohol, on the other hand, assumes a prismatic form with an angle of 30 to 40 degrees, and reddened an iron solution strongly.

"Pure morphine has the following properties. It is colorless. In boiling water it dissolves to only a slight extent, but easily in alcohol and ether, especially when warmed; these solutions taste very bitter, and it crystallizes out of them in the form described. The spirituous as well as the water solutions turn the sensitive rhubarb pigment brown, even more strongly than turmeric, and restore the blue color to litmus paper reddened with acid; in this the ammonia employed has no part, because the pure morphine retains no trace of it, as is made sufficiently clear in following out the treatment of this material with potassium hydroxide. It dissolved in the acids with which I brought it in contact very easily, and formed with them specific completely neutral compounds, which make a series of remarkable salts. Of these I will describe the following:

"Morphine subcarbonate is produced by mere contact of morphine with carbonic acid, and by decomposition of its solution with subcar-

bonate of potassium; it is more easily dissolved in water than morphine; its crystalline form I have not been able to investigate.—Morphine carbonate crystallizes in short prisms.—Morphine acetate crystallizes in fine rays and is very easily soluble.—Morphine sulphate crystallizes in branched, radiating fibers, and is also soluble.—Morphine chloride forms feathery crystals, with which the ray-forming grouping may still be found; it is notably less soluble than the other morphine salts; and, if evaporation has been carried too far it sets suddenly on cooling as a glistening, silver-white, feathery salt-mass.—Morphine nitrate arranges itself in rays which spread out on all sides from a common middle point.—Morphine meconite I have not prepared; Morphine sub-meconite however crystallizes prismatically, as it is obtained with alcohol from the opium extracted with water; it is difficultly soluble by itself, hence much water is necessary to free the opium residue entirely from it.—Morphine tartrate which crystallizes in ramified prisms shows much similarity in form to the foregoing.

"These various salts of morphine seem to be very poisonous, for after every taste I felt a pain in my head. They are rather easily than difficultly soluble in water, and almost all are of a glistening luster and seem inclined to efflorescence. . . .

"Effect of Morphine on the Human Body

"The most important property of morphine is the effect which its administration produces in animals. In order to determine this with reliability, I have used myself for the test, and also persuaded a few other persons to do so, because experiments with animals do not lead to any exact result. I consider it a duty to observe most carefully the sinister effect of this new substance, in order to prevent possible accident; for it has even been publicly stated that this drug has been taken by several persons in fairly large quantities, without recognizing any effect from it. If what was taken in these cases was really morphine, it must follow that this substance is not dissolved by the gastric juice. My earlier experiments, which seem not to be well known, had already induced me to state explicitly that this drug is not dissolved except in alcohol or in a little acid, because it is dissolved in water with difficulty, and hence without it it could not be dissolved in gastric juice.

"In order to prove my earlier researches thoroughly, I took three persons, of whom none was over 17 years old, to take morphine with me; warned by former experience, I gave each one only ½ grain dis-

solved in ½ drachm of alcohol diluted with one ounce of distilled water. A general flush, which was even seen in the eyes, spread over the face, especially the cheeks, and the life processes in general seemed speeded up. When after a half hour another ½ grain of morphine was taken, this condition was markedly increased, whereat a transient inclination toward vomiting and a dull pain in the head and stupor were experienced. Without waiting for the result, perhaps already very bad, one-quarter hour later still another ½ grain of morphine, as a course undissolved powder, was swallowed with 10 drops of alcohol and ½ ounce of water. The result was felt by the three young men quickly and in the highest degree. It showed itself by pain in the stomach, exhaustion and great faintness approaching unconsciousness. I also had the same fate; prostrate I fell into a dreamy state, and experienced in the extremities, especially in the arms, a slight twitching, which apparently accompanied the pulse-beat.

"These characteristic symptoms of a true poisoning, especially the weakened condition of the three young men, caused me such anxiety that, half unconscious, I drank over a quarter bottle (6 to 8 ounces) of strong vinegar, and also had the others do the same. This was followed by such violent nausea that several hours afterward one, of the most delicate constitution, whose stomach was already entirely emptied, suffered very serious retching, painful to the highest degree. It seemed to me that the vinegar had given the morphine this violent, unceasing emetic property. On this assumption I gave him magnesium carbonate, to which the nausea yielded at once. The night passed in a deep sleep. Toward morning the sickness appeared again, but it promptly disappeared after a strong dose of magnesia. Absence of defecation and of appetite, stupor, pain in head and body did not wear off for several days."

IVOR GRIFFITH.

"WHEN FOUND, MAKE A NOTE OF"

THIS advice from the laconic Captain Cuttle,—a benevolent sea-captain created by Dickens in Dombey & Son,—calls for us to "stand by" in order to consider some words from an address by Dr. Thomas Hunt Morgan, President of the Congress, before the International Congress of Genetics at Ithaca this August.

Dr. Morgan stated that the evolution of plant, animal, and man, is entirely the result of physical and chemical laws determined by the inexorable relation of cause and effect. The rapid expansion of genetics after 1900 has been intimately connected with the applications of the chromosome theory to the experimental work in genetics. The integrity of the chromosomes and their continuity from one cell generation to the next, the constancy in number of the chromosomes in each species, and the absence of mixing of the materials of the conjugating chromosomes, have furnished the basis on which genetics rests.

Dr. Morgan is quoted as saying, "I think we can not overemphasize the significance of this relation between the theoretical side of genetics and the factual side, as observed in the known behavior of the material basis of heredity." . . . "To put the matter bluntly, the recognition that there is a mechanism to which genetic theory must conform if it is to be productive, serves to keep us on the right track and acts as a check to irresponsible speculation, however attractive it might seem in print." . . . "Realizing how often ingenious speculation in the complex biological world has led nowhere, and how often the real advances in biology, as well as in chemistry, physics, and astronomy, have kept within the bounds of mechanistic interpretation, we geneticists should rejoice . . . that we have at command an additional means of testing whatever ideas pop into our heads."

The New York Times reports that Doctor Morgan's reaffirmation of the mechanistic, deterministic principle was regarded by the many eminent scientists present as a direct challenge to those who in recent years have tried to introduce into the fields of physics and genetics a non-deterministic, mystical element in the workings of nature. Eddington, Jeans, Smuts, and Osborne are mentioned by *The Times* as exponents of non-deterministic, mystical elements.

The reader will ponder over the advice of Captain Cuttle. If in laying his course he has been influenced by the siren calls of mysticism, he may follow Captain Cuttle further, and, "Keep her off a point or so."

DAVID WILBUR HORN.

THE GOOD OLD DEPRESSION

SOME men are claiming that they are glad to have lived in this period of depression. A poet exclaimed: "Sweet are the uses of adversity."

While we have had strenuous days and nights, as we go out of it we find that really we have gathered sense and health, and have actually become happier and better men and women.

As our securities and incomes shrank, we began to realize how crude was our condition.

We have got past some of it, and can begin to see some of the advantages of the slump.

The pharmacist, while among the hard hit, has gained in knowledge, experience, and sanity.

For one thing, he has learned that his store was overequipped, overfurnished, and overstocked.

He has learned to give a strenous "no" to high-pressure salesmen, promoters, experts, and efficiency men. He has found that he knows best how to run his own business.

The retailer has learned how to adjust volume and profits.

There has been a remodelling and readjustment of store management and sales systems. One druggist reported that he put his wife to keeping the books, placed his daughter in the toiletry department, and got behind the counter himself. This cut out three salaries, and brought increased volume and profits.

Seemingly cruel and heartless at times has been the elimination of the unnecessary and the unfit.

There have been, and there still exist, too many grocers, too many drygoods, drug stores, and shops of many kinds.

During the depression the lists of bankruptcies, mergers, combinations, closing outs, abandonments have been extended and bid fair to increase. In many cases the failure has been a blessing to the victim. He was doomed to fail eventually. The depression hastened the catastrophe and saved loss of time and property.

The depression, through elimination of the unfit, has forced many out of vocations for which they were unfitted into others in which they can better provide for themselves and better serve society.

Many graduates in pharmacy have been awakened to the fact that there are many other things which they had better do than open a new drug store.

Under stress many men have discovered in themselves new talents and resourcefulness. Adversity makes true men out of people who are made of the right stuff. Men have learned to take care of themselves, their bodies, their minds, and their families.

They walk rather than ride, thus promoting health and well-being and saving carfare and gasoline.

They use their leisure to read, study, patronize music and other arts. They live in a more rational atmosphere.

The suburban and small town druggist finds new customers in people "coming back to the land."

City mansions and apartments have been displaced by the bungalow, the back yard garden, and the chicken coop.

Men, women and children have learned to exchange their old selves for a new being.

Out of the chaotic welter there are emerging saner methods of living, more stable methods in business, including banking and monetary reform, and let us hope, governmental sense.

Our suffering has not been in vain. Our education has been worth all it has cost. We are emerging in a more sober condition.

As the clouds lift and streaks of light slowly appear in the sky we may take on new hope and courage.

We may gird ourselves for a journey which may be long, at times even tedious, but always forward.

We will need to accumulate reserves not only of money, but of saner thoughts and brains.

With these we may be rejoiced that we have lived and moved in this era of depression.

FRED B. KILMER.

ORIGINAL ARTICLES

THE RETENTION OF ALKALOIDS BY OAK SAWDUST, U. S. P.*

By Robert W. Morrison

Associate Professor of Pharmacology, University of South Carolina

and

A. Richard Bliss, Jr.

Professor of Pharmacology, University of Tennessee (Memphis)

Introduction

DURING the course of an investigation of the alkaloidal content of Nux Vomica and its preparations (1, 2) certain observations led the authors to make this side-study concerning the absorption, adsorption or retention of alkaloids by sawdust and by the marc of Nux Vomica.

The U. S. Pharmacopœia X (3) gives the following instructions for the preparation of sawdust for use as an absorbent in the proximate assay procedure called "Type Process C for Galenical Preparations—Aliquot Part Method: Sawdust should be clean, not resinous, and must not show the presence of alkaloids when tested as follows: Macerate 5 Gm. in 50 cc. of ether-chloroform mixture and 10 cc. of ammonia T. S., shaking frequently during two hours. Decant 10 cc. of the clear ethereal liquid, evaporate to dryness, and treat the residue with 1 cc. of diluted sulphuric acid. Test portions of the acid liquid for alkaloids with mercuric potassium iodide T. S. and with iodine T. S. If necessary, sawdust may be purified for use in assays by extracting it in a percolator, first with a 1 per cent. solution of sodium hydroxide, then with a 1 per cent. solution of hydrochloric acid, finally washing with distilled water until free from acid and soluble salts, and drying. The last portions of the acid percolate must give no test for alkaloid with mercuric potassium iodide T. S. or with iodine T. S."

A number of investigators have discussed the retention of alkaloidal constituents in vegetable matter, but no reports of experimental

*From the Division of Pharmacology, University of Tennessee (Memphis).

work with sawdust appear in the available literature. Palme (4), who worked with powdered Licorice as the absorbing medium, and Atropine (free) and Atropine Sulphate as the alkaloidal agents, concluded that the usual methods of exhausting alkaloid-containing vegetable drugs by the use of solvents in which these constituents are soluble fail to remove all of the alkaloids, and that an alkaloid-free drug which has been used as an absorbent for an alkaloidal solution is capable of resisting subsequent complete alkaloidal extraction by the use of a solvent in which the alkaloid is soluble. In the case of Licorice this investigator obtained retention of from 12 to 24 per cent. with the free alkaloid Atropine, and from 12 to 21 per cent. with Atropine Sulphate, the quantity of retained alkaloid increasing with the concentration. These observations confirmed those of Sjöherz (5). Odén (6) claimed that the retention of alkaloid is not due to combinations with Pectic Acid or other acid constituents of vegetable drugs.

This investigation was conducted to determine (a) whether oak sawdust retains any appreciable amounts of the alkaloids Strychnine and Brucine when these agents are added and the material subsequently extracted, and (b) whether the marc of Nux Vomica is capable of retaining determinable quantities of these alkaloids when they are added to the exhausted drug.

The Methods

Method I. Using Dried Unpurified Oak Sawdust.—Reduce the dried oak sawdust to a No. 40 powder. Use Strychnine Sulphate and Brucine Sulphate, since these alkaloids occur in combination in the crude drug. Carry out blank tests on the sawdust to establish freedom from alkaloids. Place 10 Gm. of sawdust in a 250-cc. Erlenmeyer flask, add 20 cc. each of solutions of Strychnine Sulphate and of Brucine Sulphate of known strength, dry in an oven at 100° C. Add 100 cc. of the Ether-Chloroform mixture of the U. S. Pharmacopœia X, 3 to 1 (7), after 5 minutes make alkaline to litmus with Ammonia Water (10 cc.), shake intermittently for two hours, and allow the mixture to stand overnight. In the morning, shake the flask for 30 minutes, allow the mixture to stand until the supernatant liquid is clear, and filter off 50 cc. of the ethereal layer into a separatory funnel. Extract the ethereal solution with successive portions of 5 per cent. Sulphuric Acid until the tests with mercuric potassium iodide T. S. and with iodine T. S. are negative. Complete the assay

in accordance with the U. S. Pharmacopœia X (8), determining the alkaloids by the gravimetric method.

Method II. Using Dried Purified Oak Sawdust.—Follow the procedure described in "Method I," substituting "Purified Sawdust," U. S. P. (3) for the unpurified sawdust.

Method III. Using Dried Marc From Nux Vomica.—Follow the procedure described in "Method I," substituting the dried marc from powdered Nux Vomica, shown to be free from alkaloids by the mercuric potassium iodide and the iodine tests, for the unpurified sawdust.

The Results

The results obtained with the several methods are tabulated below. Final calculations were based on the weight of anhydrous alkaloids.

TABLE 1—WITH UNPURIFIED SAWDUST

Assay No.	Wt. Strych. Added (as free Alk'd)	Wt. Brucine (Anhyd.) Added (free A.)	Wt. Combined Alkaloids (free) Recov'd	Per Cent. Combined Alk. Rec'd
1	0.10517	0.11424	0.1793	83.1
	0.10517	0.11424	0.1802	83.4
2	0.11510	0.12230	0.2370	85.5
	0.11510	0.12230	0.2351	84.9
3	0.12000	0.14360	0.2233	85.1
	0.12000	0.14360	0.2229	84.5
4	0.09860	0.07910	0.1509	84.4
	0.09860	0.07910	0.1495	84.1

Average Per Cent. of Free Alkaloids Recovered: 84.375.

TABLE 2—WITH PURIFIED SAWDUST

Assay No.	Wt. Strych. Added (as free Alk'd)	Wt. Brucine (Anhyd.) Added (free A.)	Wt. Combined Alkaloids (free) Recov'd	Per Cent. Combined Alk. Rec'd
5	0.05510	0.05110	0.0882*	83.05
6	0.05090	0.04560	0.0786*	82.00

Average Per Cent. of Free Alkaloids Recovered: 82.52.

TABLE 3—WITH MARC OF NUX VOMICA

Assay No.	Wt. Strych. Added (as free Alk'd)	Wt. Brucine (Anhyd.) Added (free A.)	Wt. Combined Alkaloids (free) Recov'd	Per Cent. Combined Alk. Rec'd
7	0.05330	0.04400	0.0967*	99.4
8	0.05570	0.04270	0.0975*	99.1

Average Per Cent. of Free Alkaloids Recovered: 99.3.

*Average of two determinations.

Discussion

From the foregoing results it is obvious that: (1) Unpurified oak sawdust retains about 16 per cent. of the added alkaloids Strychnine and Brucine, and that the retained alkaloids cannot be recovered by the ordinary methods of extraction with solvents in which the alkaloids are soluble. (2) "Purified Oak Sawdust, U. S. P." retains about 17.5 per cent. of these alkaloids, the very "purity" of the sawdust being responsible apparently for the increased retention powers as compared with the unpurified sawdust. (3) The marc from exhausted Nux Vomica yields up practically 100 per cent. of the added alkaloids, possibly because the marc is "saturated," as it were, with its own retained alkaloids, and consequently incapable of holding additional amounts against the solvent action of the solvent employed.

Conclusions

In view of the findings herewith reported, the use of oak sawdust as an absorbent in proximate assay procedures with alkaloidal preparations must inevitably yield erroneous results due to the retention of alkaloids, and consequently oak sawdust should not be employed as an absorbent in the alkaloidal assays of the U. S. Pharmacopœia.

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FRANKLIN THE DISCOVERER OF PRIESTLEY, AND PRIESTLEY THE DISCOVERER OF OXYGEN

By Joseph W. England, Ph. M.

WHO can prophesy the results that may flow from the exercise of personal influence, or the influence of one person upon another, or on others? Personal influence is the biggest factor in human relations. It is intangible and yet potential. It is, usually, unconsciously exerted and unconsciously felt. It is individual in reaction, and yet, by its results, may be reciprocal.

This is the story of the influence of a man of the world and an enthusiastic scientist—Benjamin Franklin, upon a man of the church and a famous theologian who was indifferent, if not antagonistic, to the claims of science—Joseph Priestley.

Priestley became a personal friend of Franklin's, and Franklin bred in Priestley the same love of science he had, with results that have wrought mightily for the comfort and progress of mankind.

Not only this, but Priestley's research work on gases, bred in Franklin a deep interest in the same subject, with special reference to the use of gases for aeronautics, and a number of Franklin's letters on this subject are herein given.

Benjamin Franklin

Benjamin Franklin (1706-1790) was the most remarkable man of his day and generation, and left the impress of his dynamic energy upon almost every phase of modern life. He had courage, ability, originality and initiative in unusual measure. He was many-sided in his activities, with an amazing capacity for work. He was primarily a printer and journalist. Benevolent, patriotic and philanthropic, he was, also, a philosopher and a statesman. He had a keen sense of the ludicrous, in fact, has been called "The Father of American Humor."

In addition, he was a scientist of national and international fame, and had an enthusiastic love of science, and the happy faculty of inspiring it in others.

So, when Joseph Priestley—the famous English clergyman and philosopher—became a personal friend of Franklin's, he too was inspired with a love of science and became a physicist and chemist, and discovered oxygen—a colorless, tasteless, odorless, chemically-

active gaseous element which occurs in the free state in atmospheric air and in combination with other elements as the most abundant of all the elements on the earth's surface.

Joseph Priestley

Next year will be the two-hundredth anniversary of the birth of Joseph Priestley (1733-1804).

As to the exact date of birth, "The Memoirs of Joseph Priestley," to the year 1795, written by himself, 1806, 2, in possession of the Historical Society of Pennsylvania, state: "I was born the thirteenth of March, old style 1733, at Fieldhead about six miles south west of Leeds in Yorkshire."

"While it is true," Dean Charles H. LaWall of the Philadelphia College of Pharmacy and Science, writes me, "that the Encyclopædia Britannica mentions it as March 13, 1733, I am in possession of an old biographical work published shortly after Priestley's death, in which the statement is specifically made that March 13 is *old style,* and in order to bring it up to our modern calendar requirements, 11 days would have to be added, making the celebration date March 24; for you probably remember that George Washington's birthday was really February 11, 1732."

Early Investigations

In "The Memoirs of Dr. Joseph Priestley to the year 1795," 1806, 129, entitled "A Continuation of the Memoirs of Dr. Joseph Priestley," written by his son Joseph Priestley (in possession of the Historical Society of Pennsylvania), there is contained (page 257) this significant account of Priestley's work:

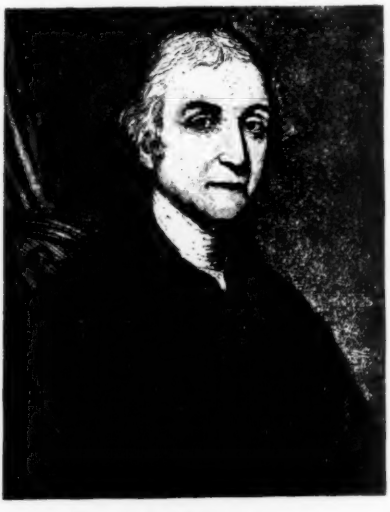
"He had obtained very good air from saltpetre in 1771, but his full discovery of dephlogisticated air seems not to have been made until June or July, 1774, when he procured it from precipitate *per se* (*i. e.,* red precipitate, J. W. E.), and from red lead. This was publicly mentioned by him at the table of Mr. and Madam Lavoisier at Paris, in October, 1774, to whom the phenomena were until then unknown. The experiments on the production of dephlogisticated air he made before the scientific chemists at Paris about the same time, at Mr. Trudaines. This hitherto secret source of animal life and animal heat, of which Mayow had but a faint and conjectional glimpse, was certainly first exhibited by Doctor Priestley, and about the same time (unknown to each other), by Mr. Scheele of Sweden,"

but Scheele's results were not published until later. "Priestley gave the first published account of the discovery of oxygen." (Alembic Club Reprints, No. 7, Edinburgh, Published by the Alembic Club, 1902.)

"Priestley obtained oxygen gas on August 1, 1774, by heating red mercuric oxide (or as it is commonly called, red precipitate) in a glass vessel by the heat of the sun's rays concentrated on the oxide by means of a burning glass, and gave it the name of *dephlogisticated air.*" ("Dictionary of Applied Chemistry," Thorpe, 1913, Vol. IV, 36.)

Claim to Fame

"Priestley's claim to fame," writes Charles H. LaWall, in his "Four Thousand Years of Pharmacy" (1927, 373-375), "rests upon his essays entitled *Experiments and Observations on Different Kinds of Air,* and *Dephlogisticated Air,* which were published in 1775 and 1776. In *Dephlogisticated Air,* Priestley had isolated what later came to be known as oxygen. He studied its properties so thoroughly that in his original essay he was able to predict many of the uses for which this gas has served in later years, such as a supporter of ebbing vitality and in the oxyhydrogen blowpipe.



Joseph Priestley.
Born near Leeds, England, 1733; died in Northumberland, Pa., 1804.

"Joseph Priestley (1733-1804), a non-conformist minister who turned to science for recreation, was one of the most highly educated men of England in the late eighteenth century. He had taught Latin, Greek, Hebrew, French and Italian, and gave lectures on logic, elocution, oratory, criticism, history, civil law, and anatomy. He had formed a friendship with Benjamin Franklin, and it was through this friendship that he turned his attention to philosophy and science.

"In 1767 he took charge of a Unitarian congregation in Leeds, and while there, began experiments with different kinds of air, utilizing the waste carbon dioxide of a nearby brewery for part of his experimental material. . . . In 1793 Priestley came to America and ended his days peacefully in 1804 at Northumberland, Pa."

The Uses of Oxygen

The discovery of oxygen and its applications have exerted a tremendous influence upon the comfort and progress of the human race. The air we breathe, the water we drink, the food we eat, the clothing we wear, in fact, almost all material things contain or are combined with this elemental gas. Perhaps one of the most striking instances of its value is to be found in its power of greatly increasing the content of oxygen in the red blood corpuscles and the oxidizing power of the latter in the tissues, so that waste products may be more rapidly oxidized and eliminated as carbon dioxide gas by the lungs. Its value as "a supporter of ebbing vitality," as Priestley quaintly expressed it in 1774, is of tremendous importance in certain diseased conditions, especially in infectious diseases.

"Oxygen was used in medicine soon after its discovery" (first used by Beddoes in 1798 (Boothby)), "but uncritically and injudiciously for every thing, and until recently, never in sufficient concentration to be effective" (R. M. Welder). In recent years, however, by the employment of face masks, mouth tubes, oxygen tents and oxygen chambers, and vastly improved methods of administration, the results of its use, especially in pneumonia, have been marvelous, giving comfort and ease to patients and greatly reduced mortality.

Atmospheric air contains about 21 per cent. by volume of oxygen and 78 per cent. by volume of nitrogen. With the inhalations of oxygen gas, its content in the red blood corpuscles (and its oxidizing power in the tissues), can be practically doubled.

If Priestley's discovery of oxygen has done nothing more, its use in medicine has saved, and will save, countless thousands of human lives.

The Discovery of Soda Water

"The first description of 'soda water' ('Four Thousand Years of Pharmacy,' 1927, 487), as the term is now used, was used in the writings of Joseph Priestley in 1772, when he gave 'directions' for impregnating water with fixed air (early name for carbon dioxide) to communicate the peculiar spirit and virtues of Pyrmont water. The manufacture of carbonated waters on a large scale was begun at Geneva in 1790 by Nicholas Paul."

It is interesting to note ("The First Century of the Philadelphia College of Pharmacy") that Elias Durand, a Frenchman, a pharmacien of the Grand Army of Napoleon, emigrated to this country in 1816, and in 1825 established a fine drug store at the southwest corner of Sixth and Chestnut Streets, in Philadelphia, with French glassware, and drugs and chemicals imported from France. He had a novel apparatus for making and vending water charged with carbon dioxide, probably the first in this country. In 1835, Durand, while Corresponding Secretary of the Philadelphia College of Pharmacy, introduced the bottling of carbonated water in this country, opening a large establishment on Sixth Street above Arch. The apparatus, especially that part of it for bottling under pressure, was his own invention, and superior to any other in use in France. Later, he sent it to The Société de Pharmacie, and it was adopted for use in Paris.

Letter of Franklin on Marsh Gas

Marsh gas (or methane) is one of the most important compounds in organic chemistry. Theoretically, at least, thousands and thousands of organic compounds may be derived from it. "It occurs in nature wherever vegetable matter is undergoing decomposition in the presence of moisture. This is always noticeable where leaves and other vegetable matter are under water, and the bubbles which rise when such a mass is disturbed are composed chiefly of this gas. It also occurs in coal seams, giving rise to the *fire damp* of miners. Closely allied with this is *natural gas* which has marsh gas for its chief constituent." (Sadtler and Coblentz.)

In a recent work of Nathan G. Goodman ("The Ingenious Dr. Franklin," Nathan G. Goodman, 1931, 145) there is reprinted

a personal letter of Benjamin Franklin to Joseph Priestley on "The Earliest Account of Marsh Gas," written in London. It is as follows:

Craven Street, April 10, 1774.

Dear Sir:

In compliance with your request, I have endeavoured to recollect the circumstances of the American experiments. I formerly mentioned to you, of raising a flame on the surface of some waters there.

When I passed through New Jersey in 1764, I heard it several times mentioned, that, by applying a lighted candle near the surface of some of their rivers, a sudden flame would catch and spread in the water, continuing to burn for nearly half a minute. But the accounts I received were so imperfect, that I could form no guess as to the cause of such an effect, and rather doubted the truth of it. I had no opportunity of seeing the experiment, but, calling to see a friend who happened to be just returning home from making it himself, I learned from him the manner of it; which was to choose a shallow place where the bottom could be reached by a walking-stick, and was muddy; the mud was first to be stirred with the stick, and, when a number of small bubbles began to arise from it, the candle was applied. The flame was so sudden and so strong, that it catched his ruffle and spoiled it, as I saw. New Jersey having many pine trees in many parts of it, I then imagined that something like volatile oil of turpentine might be mixed with the waters from a pine-swamp, but this supposition did not quite satisfy me. I mentioned the fact to some philosophical friends on my return to England, but it was not much attended to. I suppose I was thought a little too credulous.

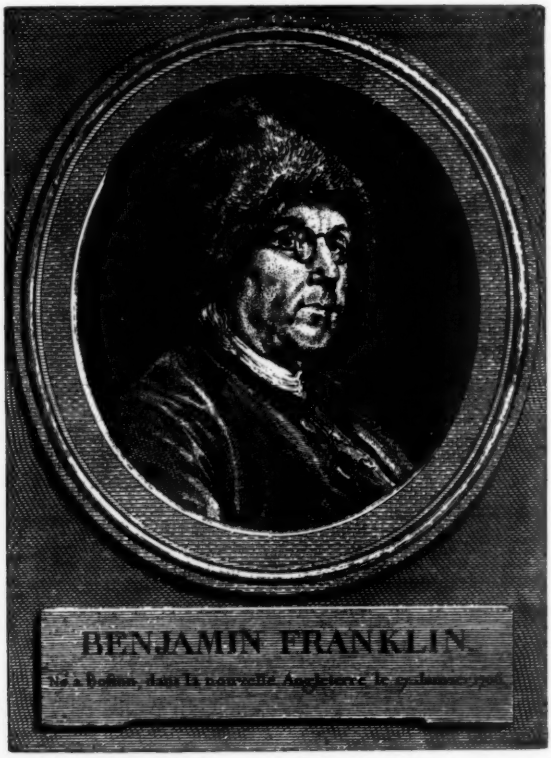
In 1765, the Reverend Dr. Chandler received a letter from Doctor Findley, President of the College in that province, relating to the same experiment. It was read at the Royal Society November 21st of that year, but not printed in the Transactions; perhaps because it was thought too strange to be true, and some ridicule might be apprehended, if any member should attempt to repeat it, in order to ascertain or refute it.

The following is a copy of that account:

"A worthy gentleman, who lives a few miles distant, informed me, that in a certain small cove of a mill pond near his home, he was surprised to see the surface of the water blaze like inflamed spirits. I soon after went to the place, and made the experiment with the same success. The bottom of the creek was muddy, and when

stirred up, so as to cause a considerable curl on the surface, and a lighted candle held within two or three inches of it, the whole surface was in a blaze, as instantly as the vapour of inflammable spirits, and continued, when strongly agitated, for the space of several seconds. It was at first imagined to be peculiar to that place; but upon trial it was soon found that such a bottom in other places exhibited the same phenomenon. The discovery was accidentally made by one belonging to the mill."

I have tried the experiment twice here in England, but without success. The first was in a slow running water with a muddy bottom. The second in a stagnant water at the bottom of a deep ditch. Being some time employed in stirring this water, I ascribed an intermitting fever, which seized me a few days after, to my breathing too much of that foul air,* which I stirred up from the bottom, and



*"Franklin's intermittent fever was certainly not due to "breathing too much of that foul air," but probably to the fact that he was bitten by a malaria-carrying mosquito, while he was working in the marsh."—(C. H. LaWall.)

which I could not avoid while I stooped, endeavoring to kindle it. The discoveries you have lately made, of the manner in which inflammable air is in some cases produced, may throw light on this experiment, and explain its succeeding in some cases, and not in others.

With the highest esteem, and respect I am, dear Sir, your most obedient humble servant,

B. FRANKLIN.

The reference of Franklin in his letter of April 10, 1774, to Priestley to "the discoveries you have lately made, of the manner in which inflammable air (or hydrogen) is in some cases produced," is significant.

The date of this letter is only a few months before Priestley made public his discovery of oxygen to Lavoisier and the scientific chemists of Paris.

Franklin's letter to Priestley may have been suggestive. Priestley knew, of course, that when hydrogen gas was burned in air, it gave a blue flame, but he may not have known that the product of the combustion was water, as it was not until 1783 that Lavoisier decomposed water in its constituent elements. Priestley had observed that when a lighted candle was placed in oxygen gas, it burned most brilliantly, but he may not have known that the products of the combustion were carbon dioxide and water. And, Franklin's report of a new gas (marsh gas) that burned like hydrogen and yielded the same products of combustion (carbon dioxide and water) as the lighted candle in air or oxygen, may have been thought-inspiring to Priestley and others.

During the twenty-five years following the discovery of hydrogen, there was an intensive investigation of the elementary and other gases by scientists, and many revolutionary discoveries were made.

"It was in 1766 that Henry Cavendish established the elementary character of hydrogen, and named it 'inflammable air.'" Lavoisier, some years later, proposed the name of hydrogen, which met with general acceptance. "The discovery of oxygen by Priestley (1774), following the observations of Rutherford (in 1772) on the presence of nitrogen, led Lavoisier to demonstrate the compound nature of the atmosphere. In 1781 Cavendish proved that air consisted of a mixture of oxygen and nitrogen in constant proportions." . . . And it was in the same year that "Lavoisier recognized the chemical nature of carbon dioxide gas and proved the presence of carbon and oxygen." (Sadtler and Coblentz.)

The fact that gases, in equal volumes, differ in relative weights, must have been observed, because it was known that hydrogen was the lightest of gases. However, "It was not until about 1803 that Dalton formulated his atomic theory of matter, and until about 1811 that Avogadro suggested that matter was composed of *molecules* made up of Dalton's *atoms,* and also enunciated the theory that 'equal volumes of all gases at the same temperature and pressure contained the same number of molecules'; and from these data it was deduced that the weight of each molecule was dependent upon the weight of the atoms composing it, and so, the relative densities of gases were dependent upon their molecular weights" (Freeman P. Stroup); and thus it was found that the density of a gas *compared with hydrogen as 1,* under standard physical conditions, was one-half its molecular weight.

Practically, air is 14 times as heavy as hydrogen, oxygen 16 times, nitrogen 14 times, carbon dioxide 22 times, carbon monoxide 14 times, marsh gas 8 times, chlorine 35 times, sulphur dioxide 32, ammonia 8.5 times and helium (discovered in 1894) twice as heavy.

As early as 1783, therefore, or before it was recognized that hydrogen was the lightest gas known, and its use for balloon ascensions suggested. Thus, Franklin wrote to Sir Joseph Banks, on August 30, 1783, on "The First Hydrogen Balloon" ("The Ingenious Dr. Franklin," 1931, 89), as follows:

THE FIRST HYDROGEN BALLOON
TO
SIR JOSEPH BANKS

Passy, Aug. 30, 1783.

Sir:

On Wednesday the 27th inst., the new aerostatic experiment, invented by Messrs. Mongolfier of Anonnay was repeated by Mr. Charles, Professor of Experimental Philosophy at Paris.

A hollow globe 12 feet diameter was formed of what is called in England oiled silk, here Taffetas *gommée,* the silk being impregnated with a solution of gum-elastic in lintseed oil, as is said. The parts were sewed together while wet with the gum, and some of it was afterwards passed over the seams, to render it as tight as possible.

It was afterwards filled with the inflammable air that is produced by pouring oil of vitriol upon filings of iron (*i. e.,* hydrogen, J. W. E.), when it was found to have a tendency upwards so strong as to be

capable of lifting a weight of 39 pounds, exclusive of its own weight which was 25 lbs. and the weight of the air contain'd.

It was brought early in the morning to the *Champ de Mars,* a field in which reviews are sometimes made, lying between the Military School and the river. There it was held down by a cord, till 5 in the afternoon, when it was to be let loose. Care was taken before the hour to replace what portion has been lost of the inflammable air, or of its force, by injecting more.

It is supposed that not less than 50,000 people were assembled to see the experiment, the *Champ de Mars* being surrounded by multitudes, and vast numbers on the opposite side of the river.

At 5 o'clock notice was given to the spectators by the firing of two cannons, that the cord was about to be cut. And presently the globe was seen to rise, and that as fast as a body of twelve feet diameter with a force only of 39 pounds, could be suppos'd to move the resisting air out of its way. There was some wind, but not very strong. A little rain had wet it, so that it shone and made an agreeable appearance. It diminished in apparent magnitude as it rose, till it enter'd the clouds, when it seem'd to me scarce bigger than an orange, and soon after become invisible, the clouds concealing it.

The multitude separated, all well satisfied & much delighted with the success of the experiment, and amusing one another with discourses of the various uses it may possibly be apply'd to, among which many were extravagant. But possibly it may pave the way to some discoveries in natural philosophy of which apparently we have no conception.

A note secur'd from the weather had been affix'd to the globe, signifying the time & place of its departure, and praying those who might happen to find it, to send an account of its state to certain persons at Paris. No news was heard of it till the next day, when information was receiv'd, that it fell a little after 6 o'clock at Gonesse, a place about 4 leagues distance; and that it was rent open, and some say had ice on it. It is suppos'd to have burst by the elasticity of the contain'd air when no longer compress'd by so heavy an atmosphere.

One of 38 feet diameter is preparing by M. Mongolfier himself at the expence of the Academy, which is to go up in a few days. I am told it is constructed of linen & paper and is to be filled with a different air, not yet made public, but cheaper than that produc'd by the oil of vitriol, of which 200 Paris pints were consum'd in filling the other.

It is said that for some days after its being fill'd, the ball was found to lose an eighth part of its force of levity in 24 hours; whether this was from imperfection in the tightness of the ball, or a change in the mixture of the air, experiments may easily discover.

I thought it my duty, Sir, to send an early account of this extraordinary fact, to the Society which does me the honour to reckon me among its members; and I will endeavor to make it more perfect, as I receive further information.

With great respect, I am, Sir,

B. FRANKLIN.

P. S. I just now learn, that some observers say, the ball was 150 seconds in rising, from the cutting of the cord till hid in the clouds; that its height was then about 500 toises, but, moved out of the perpendicular by the wind, it had made a slant so as to form a triangle, whose base on the earth was about 200 toises. It is said the country people who saw it fall were frightened, conceiv'd from its bounding a little when it touch'd the ground, that there was some living animal in it, and attack'd it with stones and knives, so that it was much mangled; but it is now brought to town & will be repaired.

The great one of Mongolfier, is to go up as is said, from Versailles, in about 8 or 10 days. It is not a globe but of a different form, more convenient for penetrating the air. It contains 50,000 cubic feet, and is supposed to have a force of levity equal to 1500 pounds weight. A philosopher here, M. Pilatre de Rozier, has seriously apply'd to the Academy for leave to go up 'in it, in order to make some experiments. He was complimented on his zealous courage for the promotion of science, but advis'd to wait till the management of these balls was made by experience more certain & safe. They say the filling of it in M. Mongolfier's way will not cost more than half a crown. One is talk'd of to be 110 feet diameter. Several gentlemen have ordered small ones to be made for their amusement; one has ordered four of fifteen diameter each; I know not with what purpose, but such is the present enthusiasm for promoting and improving this discovery, that probably we shall soon make considerable progress in the art of constructing and using the machines:—

Among the pleasantries conversation produces on this subject, some suppose flying to be now invented, and that since men may be supported in the air, nothing is wanted but some light handy instruments to give and direct motion. Some think progressive motion on

the earth may be advanc'd by it, and that a running footman or a horse slung & suspended under such a globe so as to leave no sense of weight pressing the earth with their feet, than perhaps 8 or 10 pounds, might with a fair wind run in a straight line as fast as that wind, and over hedges, ditches & even waters. It has been even fancied that in time people will keep such globes anchored in the air, which by pullies they may draw up game to be preserved in the cool, & water to be frozen when ice is wanted. And that to get money, it will be contrived to give people an extensive view of the country, by running them up an elbow chair a mile high for a guinea, etc., etc.

This letter was written nearly a century and a half ago. And what amazing prescience Franklin showed when he wrote of the "First Hydrogen Balloon" Ascension of 1783, that the experiment might be applied to many uses then deemed extravagant, and might pave the way to discoveries in natural philosophy of which there was then no conception; also, that to make flying possible with man, nothing was needed but some light handy instruments to give and direct motion; also, that when needs be, such balloons could be anchored in the air!

It's a long cry from the hydrogen balloon of 1783 to the modern helium (a non-inflammable gas) dirigible, but what tremendous strides in the development of aviation have been made since then.

Other Letters by Franklin on Balloon Ascensions

In "The Ingenious Dr. Franklin," there is published, also, a letter (p. 94) on "A Hot Air Balloon," to Sir Joseph Banks, from B. Franklin, at Passy, France, under date of October 8, 1783; also, a letter (p. 96) on the "First Aerial Voyage by Man," to Sir Joseph Banks, from B. Franklin, at Passy, under date of November 21, 1783; also, a letter (p. 99) on "Second Aerial Voyage of Man," to Sir Joseph Banks, from B. Franklin, at Passy, under date of December 1, 1783; also, a letter (p. 103) on "A Prophecy on Aerial Navigation," to Jan Ingenhousz, from B. Franklin, at Passy, under date of January 16, 1784.

First Balloon Ascension in the United States

According to N. H. Randers-Pehrson (*Philadelphia Public Ledger*, July 3, 1932), in a most interesting article, the first balloon ascension in the United States was made by Jean Pierre Blanchard, the

celebrated French aeronaut, from the yard of the old Walnut Street Prison in Philadelphia, on January 9, 1793, at 10 A. M.

"Blanchard had brought the complete equipment from Europe, a splendid silk balloon, apparatus for the inflation, and even the vitriolic acid necessary for the generation of hydrogen, as he feared the chemical industry here was not sufficiently developed to supply it. His fame had preceded him. He had been the first man to ascend in Germany, the first in Holland, and the first in Belgium, and now he was to be the first in the New World. But he had won his greatest renown by accomplishing the first aerial crossing of the English Channel.

Jean Pierre Blanchard.

"Blanchard, a little fellow in a blue suit and cocked hat with white feathers, was the centre of preparations in the prison yard. A band played and two cannons were fired every fifteen minutes during the inflation. The great yellow silk bag bulged and took shape under the strong net. At 10 o'clock it was ready. The car, neatly decorated in blue and gold, was attached, ballast taken in, and the instruments arranged. Refreshments for the aeronaut of wine and biscuits were placed in the car. He now took leave of the President, the Minister from France, M. Ternan, and the public in general.

George Washington personally handed the aeronaut a passport, and addressed a few words to him, wishing him a pleasant voyage. The passport was necessary because the Frenchman spoke no English.

"Another round of artillery announced that everything was ready. Blanchard leaped into his car, threw out some ballast, gave the final order to his assistants to "let go" and ascended. The crowd was so impressed with the novel spectacle that deep silence ruled for a few moments before the applause broke loose. The balloon ascended perpendicularly. Blanchard flourished his cocked hat and waved his flag, which was decorated on one side with the arms of the United States and on the other with the colors of France. At an altitude of about 200 feet the balloon encountered a breeze, and was rapidly carried toward the southeast. In a few minutes it disappeared from view, and a group of gentlemen who galloped in pursuit down the road, on horseback, soon lost sight of it. The speed of the balloon was estimated to be about twenty miles an hour. The aeronaut landed at a place a little east of Woodbury, N. J., about fifteen miles from Philadelphia. He did not have the slightest idea where he was. Within a short time several ladies and gentlemen arrived on horseback. They were both astonished and pleased at the sight of the balloon, and asked a lot of questions which Blanchard could not answer because he did not understand their language. But the passport from George Washington served instead of an interpreter. The balloon had been in the air fifty-six minutes. The balloon was soon packed and Blanchard returned to Philadelphia and immediately hurried to the President's house to pay his respects to George Washington, and to give him a full account of the voyage, and to tell him of the excellent effect of the presidential passport. As a sign of gratitude he offered his flag, which Washington politely accepted.

"The ascension had been a great success—the first successful air voyage ever performed in America."

How it would have delighted the soul of Benjamin Franklin, who died in 1790, and whose body was interred only a few squares distant from the yard of the old Walnut Street Prison, in Philadelphia, on Walnut Street between Fifth and Sixth Streets, to have seen the first balloon ascension in the United States in 1793, and to have described it, as he had seen and described the first balloon ascension in the world, at Passy, France, in 1783!

PITFALLS ENCOUNTERED BY THE NOVICE IN VITAMIN-A ASSAY WORK

By George E. Ewe

THE determination of vitamin-A by the rat-growth method is primarily a feeding process. It cannot, however, be likened to "throwing the mare a fork-full of hay" as expressed by one lay observer, since, in practice, careful attention to seemingly slight details is necessary for satisfactory results.

Several very practical methods of determining vitamin-A have been published and it is not the intention to here outline still another method. Most of these published methods are in sufficiently detailed form to be readily understood and significant to the initiated or expert, but the beginner or inexperienced will often fail to appreciate the importance of many of the details.

Some of the pitfalls in vitamin-A assay procedures which are known by the writer to have been encountered by beginners and others inexperienced in the art will be briefly discussed in this article. Practical means of avoiding these obstacles to success in the determination of vitamin-A will also be discussed. It is believed that this discussion may tend to emphasize the significance of these details and thus lead to a more thorough appreciation of their importance by the novice.

Inadequate breeding diet, resulting in poor reproduction and non-sturdy young:—inadequate breeding diets have been found in use which resulted in an almost total lack of reproduction, or small litters, or in the production of young which lived but a short time, or were hydrocephalic, or which were low in weight, or stopped growing (or grew but little) when placed on the vitamin-A-free diet at the age of twenty-eight days. One such diet (a brand of dog biscuit, supplemented with lettuce and boiled bones) was also encountered which led to cannibalism among the rats, the young being the victims.

A diet composed of rolled oats 39 parts, whole wheat flour 30 parts, cornmeal 20 parts, whole milk powder 9 parts, common salt 1 part and meat scraps 1 part, supplemented with cod liver oil, lettuce, boiled bones and a couple of sunflower seeds daily per rat was found to yield many and sturdy litters, but the proportion of cod liver oil had to be carefully regulated so as not to overendow the young with vitamin-A. The Sherman ration composed of whole wheat 66, whole milk powder 33, and common salt 1 part was found in use by two

laboratories, both of which reported meagre reproduction on this diet. In one of the laboratories the Sherman diet was supplemented with meat and lettuce without material improvement although what young was obtained were satisfactory for testing purposes. The breeders' diet outlined in the Report of the Vitamin-A Assay Committee of the American Drug Manufacturers Association appearing in "Drug Markets," Vol. 28, No. 5, May, 1931, has been found in this investigation to yield many and sturdy litters suitable for vitamin-A assay purposes.

Extreme ranges of temperature in breeding and testing quarters has been met with. Reproduction has been stopped entirely over the cold months of the year when the temperature in the breeding quarters ranged between 50 and 94° F., this great range being due to lack of thermostatic control, whereas when the temperature was held between 66 and 72° F. by automatic electrical heating equipment, reproduction was normal. A laboratory in a southern city also reported poor reproduction duing the hot summer months. Extreme ranges of temperature in the testing quarters has resulted in irregularities in the results of vitamin assays and a larger proportion of deaths than when the temperature varied less greatly.

Too liberal endowment of young with vitamin-A has been encountered. This is due to excessive vitamin-A content of the breeding diet and the diet of the young preceding the depletion diet. It results in slow depletion of vitamin-A or even failure entirely of the growth curve to "flatten" or "break" within a reasonable period of time. In the meantime, the rats usually become too large for accurate vitamin assay work. This can be overcome by reducing the vitamin-A content of the breeding diet and the diet of the young preceding the depletion period.

Casein containing insensible moisture has been encountered and reported by several laboratories. This casein was sensibly dry, but contained sufficient moisture to cause it to clump up and prevent thorough extraction with alcohol. Such casein must be dried thoroughly at high temperature (under 100° C.) before extraction. Cases were observed where extraction of such casein was attempted without preliminary drying and when the apparently exhausted casein was then used in making a depletion diet it was found impossible to deplete rats of vitamin-A with it.

Variation in ingredients of depletion diet as the test progresses has been met with. Each successive batch of each ingredient of the

depletion diet is subject to more or less variation. Since the control rats as well as the test rats are fed out of the same diet this variation may be of no significance. However, good practice would seem to indicate that any possible irregularities in results from this source should be prevented by reserving sufficient of each ingredient to last throughout the test, before the test is started.

Inadequate proportion or poor grade of yeast in depletion diet resulting in insufficient food consumption and the appearance of vitamin-B deficiency maladies, among the rats. Inadequate yeast factors, in the diet has been repeatedly observed to lead to low food consumption during the dosing period in spite of the fact that food consumption was satisfactory during the depletion period. Loss of hair was also often seen when the diet was inadequate in yeast factors, and a "knotty" condition of the tail has been observed coincident with this type of inadequate diet. Yeast used in vitamin-A determination should have a vitamin-B complex potency such that not more than 150 mgm. daily should be required to allow recovery on the Sherman and Spohn basal vitamin-B complex ration and the yeast should be of such a grade that when used in sufficient proportion it will insure adequate food consumption in the dosing period as well as in the depletion period and also prevent the appearance of maladies due to vitamin-B complex deficiencies, evidenced by loss of hair, "knotty" tail, etc. Preferably, the food consumption should be somewhat greater during the dosing period than during the depletion period since the rats are somewhat larger during the first-mentioned period.

Use of food cups allowing loss of food has been observed. This makes the actual amount of food consumed uncertain. The food consumption should always be recorded and all spilled food recovered and accounted for so as to be certain rats are consuming enough food for maintenance. Many rats show a disposition to paw the food out of the food cup. Loss from this source can be circumvented by the use of a cylindrical food cup with a tight-fitting cover shaped like a funnel with the stem end down and with the stem and adjacent portion of the funnel cut away so as to make a round opening measuring about one and five-eighths inches in diameter to allow the rat access to the food in the cup. This funnel-shaped cover allows any food dragged onto it, or dropped upon it, by the rat, to work its way back into the cup. A flange on the base of the cup extending beyond the outside line of the cup prevents upsetting of the cup by the weight of

the feeding rat; or the cup may be hung upon, or attached to, the side of the cage.

Copraphagy was encountered by several laboratories, the rats being observed to reach down for and then munch the excrement squirrel-fashion. This practice vitiates results by affording vitamin to the animal and must be prevented by the use of screen-bottom cages with a pan or tray, to catch the droppings; the pan or tray being far enough below the bottom of the cage to be beyond the reach of the hand-like paws of the rats.

Accumulation of slime in water receptacles was encountered. There is some possibility that this type of plant life may afford some vitamin-A and cause irregularities in vitamin-A assay work. Consequently, water receptacles, aside from considerations of cleanliness, should be kept clean and free from slime.

Failure to recognize propitious time to start administration of the vitamin-A preparation has been noted as a frequent obstacle to accurate results in vitamin-A assay work. The tendency is to allow too much time to elapse after the first manifestations of depletion are evident, before starting the dosing period. In regard to this feature, Sherman * says "one can learn by experience about when to expect cessation of growth and will also be guided by the general appearance of the animals in determining when the fore-period should end and the test-period begin. This should be after the animals have certainly used up their previous reserve store of vitamin-A but before they have been permanently injured by the vitamin-A deficiency." It is the successful practice of some laboratories to wait for as much as seven days of stationary or declining weight before starting the dosing period. Others wait only two days as a longer period of stationary or declining weight results, in their case, in excessive loss of test animals. Manifestation of eye-symptoms due to vitamin-A deficiency is practically a certain criterion of the necessity of beginning the dosing period. In the Laboratory of the Tailby-Nason Company, 36 per cent. of the rats which developed eye-symptoms during the vitamin-A tests did so almost, or quite, simultaneously with the start of cessation of growth, while 56 per cent. showed eye-symptoms some time later. Only 8 per cent. developed eye-symptoms before the start of cessation of growth and these occurred but shortly before that period.

*"The Vitamins," by H. C. Sherman and S. L. Smith.

Failure of test rat to readily consume dose of vitamin-A preparation is frequently encountered, although, generally, the rat will eagerly take the dose when it is placed before it, seeming to sense its need of the vitamin. When rats fail to do so it becomes necessary to tempt their appetite; at least, until they learn to consume the dose without coaxing. The use of dried yeast upon which the dose is dropped is advocated by some. A drop or two of simple syrup upon which the dose is floated has been suggested by Dr. Clifford S. Leonard of Tuckahoe, N. Y., and this has proven very practical in actual use.

Failure to recognize the importance of discarding from the results exceptionally vigorous or exceptionally weak animals encountered during the depletion or dosing periods, or both—this has been encountered. Since the test deals with live animals occasional exceptional performance by certain individuals is certain to be evidenced. A uniformity in performance of from 60 per cent. to two-thirds or more of the animals in a group, or "dose level," is generally considered satisfactory.—*Research Laboratories, Tailby-Nason Company, Boston, Mass.*

COPPER, MAN'S FIRST USEFUL METAL*

By C. C. Pines, B. Sc.

COPPER, the first useful metal discovered by man, and probably the first metal known to man, is thought to have been found in the neolithic age perhaps as early as 13000 B. C.

C. C. Pines, B. Sc.

Imagine a hunter of the Stone Age, while stalking some prehistoric animal, finding a strange reddish-brown rock, which, upon being struck with his stone hammer, was bent and dented by the blow. The hunter finding this colored rock was different from other stones he had handled, probably took it to one of the toolmakers of the day, who perhaps tried to chip the rock and found that instead of chipping, a sharp edge was exposed to the touch. The reddish-brown rock was indeed a nugget of native copper. Presuming still further, it could have happened that the native copper was fashioned into a dagger or other implement by the toolmaker, thus beginning the use of this metal in a primitive way. Today it is said that there are about six hundred uses for copper where it is practically indispensable.

The prehistoric Egyptians 8000 years ago knew how to beat native copper into sheets from which they made knives and harpoons, and at a later period tools such as chisels and adzes. These tools were all shaped like the former neolithic types of flint and stone implements. One adze blade of this early period was so well made and so highly polished that it is thought that it was cast and then polished, because there are no marks visible, showing hammering or grinding. The Egyptian coppersmith had become so expert in 2750 B. C. that it was not too great a task to hammer out and form pipes of copper for the rainwater drains of the temple of King Sa-hu-Rē at Abusir, a project requiring 1300 feet of pipe. In 1907 a German archaeologist uncovered the ruins of this temple, and under a heavy stone doorsill found a length of the copper pipe. It was apparently made by being hammered over a form, for the seam was a lap seam and not one made by

*One of a Series of Popular Science Talks given at the Philadelphia College of Pharmacy and Science, 1932 Season.

soldering or brazing. This hand-wrought copper drainpipe is mute evidence of an industry that was well developed. The pipe on analysis contained about 96.5 per cent. of copper.

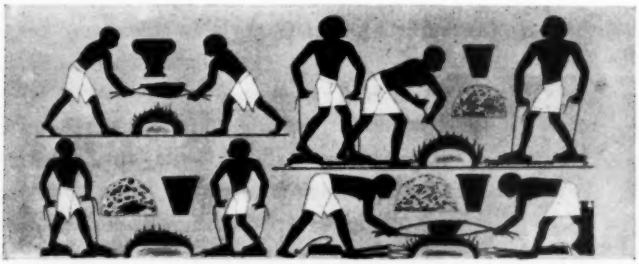


Fig. 1—Workshop of the Copper Founder—Egyptian. Melting the Copper in the Ancient Blast Furnace.

From Egyptian wall paintings of 2160 to 1788 B. C., it is believed that smelting methods for working gold and copper were practiced also, and that by the time of Rekh-my-Re (1471 to 1449 B. C.) considerable advance in this art was shown. One painting on his tomb at Thebes shows the melting of copper in the ancient blast furnace, in which the metal is being smelted in crucibles over a charcoal fire. The fires are being blown by curious bellows worked by the feet, thereby utilizing the weight of the body in the operation, the tops of the bellows being pulled up, to inhale air, by a rope in the worker's hand. A second painting shows the melted copper just made being used in casting the doors of the Temple of Karnak. Two workmen can be seen handling the crucible containing the melted copper, pouring it into the mold. To the right of the mold a laborer empties a basket of charcoal, and above him are the outlines of the doors, which are formed with bosses to fit into the sockets that were to be cut in the stone doorway. In the upper right-hand corner of the painting can be noted an inscription reading: "Bringing in the ingots of copper from the land of Syria for making the two doors of the temple of Amen at Karnak." Below the inscription are the carriers of the copper, bearing the ingots on their shoulders, accompanied by an overseer with a rod in his right hand.

Well within the influence of the ancient Egyptian civilization was the Island of Cyprus, in the Mediterranean, which had a natural wealth in copper. Rome obtained most of its supply of copper from this island, and the metal came to be known as aes cyprium, which was

gradually shortened to cyprium, and then corrupted into cuprum; whence came the English word "copper," the French "cuivre," and the German "kupfer." To both the Romans and Greeks the metal and its alloys were indifferently known as aes (Latin) and chalcos (Greek).

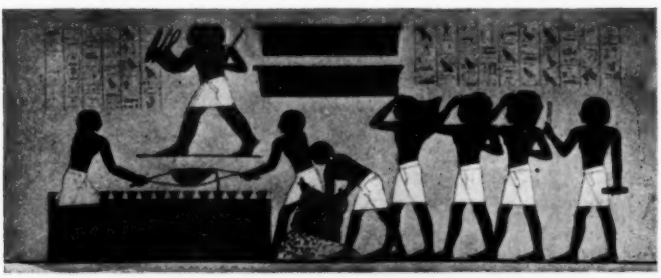


Fig. 2—Workshop of the Copper Founder—Egyptian. Casting the Doors of the Temple of Karnak.

The symbol used to designate copper in modern literature is the abbreviation Cu, which is derived from the word cuprum. The ancient symbol for copper, the one used by the alchemists (experimenters of centuries ago who tried to change the baser metals into gold) is the same as the astrological symbol for the planet Venus.

The American Indians as well as the Egyptians knew how to work copper, no doubt, many centuries ago. The Indians of the Great Lakes territory found copper nuggets and veins of copper which were exposed by the great ice movement of the glaciers of the ice age in America. In time they duplicated practically all of the flint tools and implements which they had, making them from native copper. In addition they hammered the metal out into sheets, fashioning disc-shaped breastplates. They also made bracelets, fishhooks, beads, needles with eyes, and many other objects impossible to form out of flint.

Copper mining was carried on by the Indians, and some workings of great interest have been discovered. One working in the Great Lakes region was uncovered in 1847, where, after the rubbish was cleared out, many stone hammers were discovered. At a depth of eighteen feet there was a mass of native copper which probably weighed more than six tons. This mass was found resting upon billets of oak supported by sleepers of the same wood. The wood had

lost all of its solidity and a knife would penetrate it as easily as if it had been peat; the copper was supported by earth that had fallen around it and had been raised about five feet by the ancient miners. From similar workings in the same locality cartloads of ancient hammers were taken. A copper chisel was found also, having a socket in which were the remains of a copper handle.

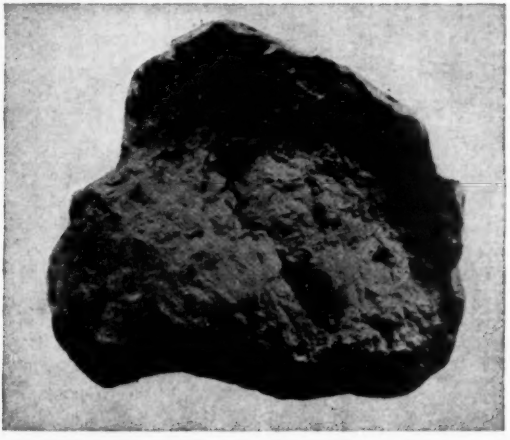


Fig. 3—The Celebrated Ontonagon Copper Boulder, Weight About Three Tons. Now in National Museum, Washington, D. C.

The most celebrated relic of the ancient American miners is the Ontonagon copper boulder in the National Museum at Washington, D. C. It weighs about three tons and was found about two miles from the place it is thought it originated. This particular boulder was known in 1766 and was removed to the National Museum in 1858, to remain for all time as a monument to the industry of the earliest Americans.

Copper, as was mentioned previously, is found in nature native or free; that is, as uncombined copper, sometimes very pure, running as high as 99.92 per cent. of the metal, with traces of silver, iron, nickel, and arsenic.

Copper is also found in the feathers of certain birds, the plantain eater (the touraco), has as much as 7 per cent. of copper in the red coloring matter (turacine) of the feathers. It is found, too, in the cuttle fishes, oysters, lobsters, scorpions, and the herring. Chocolate and cocoa contain one part of copper in 100,000 parts by weight.

In the mineral kingdom copper is not only found native, but also occurs combined in sulphides, oxides, carbonates, sulphates, phosphates and silicates. Native copper, the sulphides, oxides and carbonates are the most important ores, in other words, they are the minerals from which metallic copper can be obtained, economically.

The mineral names of the more important sulphides are chalcocite (copper glance), chalcopyrite (yellow copper ore), tetrahedrite (gray wheel ore), covellite (indigo copper), enargite, bournonite (cog wheel ore), and bornite (purple copper ore, horse flesh ore, peacock copper). The last named ore when freshly fractured exhibits a peculiar reddish bronze color which led the miners in the Cornwall district of England, a little fancifully, to call it horse flesh ore. The fresh fractured surface soon becomes slightly colored even after a day or two, and gradually the color changes and becomes more variegated, until it is, indeed, a peacock-colored mineral called peacock copper.

The important oxides are tenorite (melaconite), and cuprite (ruby copper ore). The latter is sometimes found in the form of long threads or slender hairs called chalcotrichite or plush copper.

The green carbonate of copper, malachite, and the blue carbonate of copper, azurite, are used not only as a source of copper metal but malachite especially, is used, as found for ornamental purposes, in making of table tops and vases, and in jewelry.

The sulphates of copper found in nature, brochantite and chalcanthite are not of much importance, commercially. The naturally occurring phosphates, libethenite and torbernite, the latter a copper uranium phosphate, and the chlorides, footeite and atacamite, are of minor importance. The silicates of copper are dioptase and chrysocolla, the latter is an ore of copper and is also, sometimes, cut and polished for gem purposes. At times, it is substituted for the turquois which is a copper aluminum phosphate.

Copper minerals occur quite widely distributed throughout the world. Native copper is found in England, Germany, South America, Siberia, Australia, Canada, and the United States. Its most important occurrence in North America is in the Lake Superior region, although some is found in Arizona and New Mexico associated with other copper minerals. In the Lake Superior region, the main locality is the Keweenaw Peninsula in Northern Michigan. This peninsula extends from the southern shore of Lake Superior in a northeast direction for about 100 miles and it is this area that is known as the great Copper Country of Upper Michigan.

The ore in this peninsula occurs disseminated through rocks having almond-shaped cavities (amygdaloid rocks) and conglomerates (fragments of rock cemented together). The ore averages a little more than one per cent. copper and is mined underground and brought to the surface by means of suitable hoisting device where it is crushed to suitable size for shipping. It is then shipped to the concentrating mill where jigs, tables or flotation machines separate the valuable part from the gangue (waste material). The "concentrate," as the product of the concentrating mill is called, is sent to the smelter who puts it into a reverberatory furnace where the high heat melts the copper which being heavier than the waste material, sinks to the bottom in the furnace and the waste floats on top of the molten mass. The waste is then removed and the copper is further refined by blowing air into it, to oxidize any remaining impurities, some of the copper being oxidized at the same time. The oxidized copper is then reduced usually by means of carbon, cast into ingots and sold as "lake" copper.

Minerals which are compounds of copper occur as widely distributed and even more so than native copper. In addition to the countries named before, minerals which are copper compounds, are also found in Mexico, France, Hungary, Spain, Sweden, and Africa.

The sulphide ores such as chalcopyrite and covellite from which a large proportion of commercial copper is obtained, are much more difficult to work than is native copper ore and very often elaborate schemes of treatment are necessary to get the metallic copper. This happens because many of these ores contain large quantities of iron as well as copper combined with the sulphur, and both iron and sulphur have to be removed before the metallic copper can be used for commercial purposes.

The first treatment of the sulphide ore is concentrating to remove as much gangue as possible after which the "concentrate" is roasted, thus driving off some of the sulphur as sulphur dioxide, leaving copper and iron oxides. Next the roasted material is treated in a blast furnace along with sand if necessary and coke. Some of the iron is removed in the slag formed in the blast furnace and the product at this stage is a dull-colored mass known as copper "matte" (matte is French for dull). The next stage is the melting of the matte in a converter (a retort-like furnace) with the proper fluxes to remove the rest of the iron in the slag and at the same time any sulphur remaining from previous treatment, escapes as sulphur diox-

ide. The converter is so constructed that the slag and the melted copper can be drawn off separately. The melted copper gives off some dissolved sulphur dioxide as it solidifies and, from its appearance, due to the bubbling of the escaping gas, is called "blister" copper.

During the converter treatment just mentioned air blasts used to oxidize iron and sulphur in the procedure for their removal, also oxidizes some of the copper to oxide which dissolves in the blister copper. The blister copper must therefore be treated by a deoxidizing method to produce what might be called commercial copper, copper metal pure enough for some purposes but not refined enough for all purposes. Deoxidizing of blister copper is done by melting it and then "poling" the melted mass by stirring with poles of green wood. The wood in contact with the melted copper gives off gases which combine with the oxygen in the oxidized copper reducing the molten mass of blister copper entirely to copper metal. If the product called "poled" copper is to be freed from small quantities of metals which may still be present, it is refined electrolytically.

The electrolytic process is carried out by passing a direct current of electricity such as that produced by a storage battery through a solution of copper sulphate in sulphuric acid in which the electrodes are copper. The electrodes or contact poles of the cell in which the electrolysis is to take place, are connected to the source of electricity, the one connected to the negative source is called the cathode or negative electrode and the one connected to the positive source, the anode or positive electrode. In this refining method, plates cast from poled copper about three feet square and from three-quarters to one and a half inches in thickness are the anodes and thin sheets of pure copper are the cathodes. As the direct current passes, copper from the copper sulphate solution deposits on the pure metal of the cathode encrusting it with copper and at the same time, copper dissolves from the impure anode plate replenishing the copper sulphate solution; this process keeps on until the plate of copper making up the anode is reduced to a skeleton when a fresh plate is inserted. During the electrolysis, impurities of gold and silver fail to dissolve in the acid copper sulphate solution and as "anode mud" fall to the bottom of the cell or vat which holds the solution; other impurities such as iron and zinc go in solution and remain there, so that in effect, there is a double sifting process in which the gold and silver drop away from the copper, the iron and zinc being soluble in the acid solution remain behind when the copper electrode is removed. The encrusted cathodes mentioned

above may run as high as 99.8 per cent. copper. They are placed in large reverberatory type furnaces for the last refining and after a smelting treatment, the melted copper of the cathode, having a purity now of 99.95 per cent., is cast into suitable shapes for use in the wire mills or in the manufacture of alloys.

Much sulphide ore is of low grade, perhaps containing only 2 per cent. of copper ore and 98 per cent. rock material. This low grade ore has in recent years been economically worked by a flotation concentration process rather than the old method of washing the rock material away from the copper ore in order to concentrate it. The flotation process is an application of the familiar fact that liquids will wet certain substances but not others. Water for example will wet glass but not paraffin. The process is carried out by mixing the finely ground ore with a "collector," a coal tar-creosote mixture and a "frother" such as pine oil; so called flotation agents as xanthates, mercaptans or acids may be added also. Air is then bubbled through the mixture forming a froth consisting of bubbles each surrounded by a film of oil. The bubbles adhere to the particles of ore causing this heavy material to rise or float while the rock material does not take to the bubbles and sinks away from the ore. Sort of an upside down method, the heavier particles floating while the lighter particles sink but regardless of this paradox if the process is carried out with care, as much as 90 per cent. of the copper ore will be found in the froth, and the material to be treated in the subsequent smelting may be reduced to a fifteenth of its original bulk.

The froth-flotation process is now conducted on an enormous scale for the concentration of low grade ores of a number of different metals. Of copper ore alone, in the United States, it is estimated that not less than sixty million tons of low grade ore are treated each year. Ores that could not be profitably worked by other concentration methods are now mined and smelted, so that the flotation process has made available vast deposits of minerals which were practically worthless in former years.

To obtain metallic copper from the ores containing the carbonates and oxides, a much easier procedure may be used than in the case of the sulphide ores, such as heating with charcoal in a blast furnace; sand or some other flux material may be added to form a slag in which the impurities can be concentrated and removed. At present the oxide and carbonate ores are generally mixed with sulphide ores

and this mixture is then put through the regular sulphide process previously described.

Oxide ores which are very low in copper oxide content are worked by a leaching method in which sulphuric acid is the usual leaching agent used. The ore is placed in vats of tarred or lead-lined wood, acid proof brick or asphalt concrete, the sulphuric acid is added and the copper oxide is leached out, forming a solution of copper sulphate from which the copper is obtained either by electrolysis or by being displaced by metallic iron. Most any kind of iron can be used but in practice the cheapest iron, including the tin can (tinned iron), serves the purpose. When iron is used the copper precipitated by displacement is impure, largely because rust from the iron is mixed with it. Accordingly, the impure copper is worked up in the reverberatory furnace and copper metal is finally produced.

Copper is peculiarly reddish in color by reflected light and has a bright metallic luster, but in transmitted light, thin layers of it are green. Copper has a specific gravity of 8.92 at 20° C., a melting point of 1083° C. and a boiling point of 2310° C.; when near the melting point, it is brittle enough to be powdered. Copper heated and cooled slowly, is brittle, cooled rapidly, it is soft, malleable and ductile. It ranks next to gold and silver in the scale of malleability, and can be beaten into thin sheets by hammering or by the pressure of rolls.

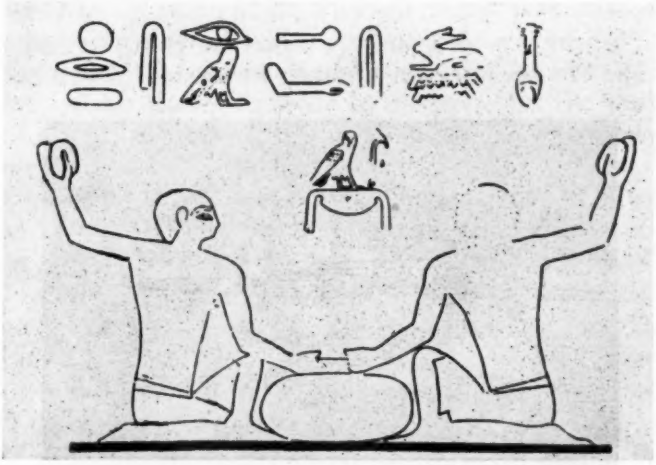


Fig. 4—Beating Metal Into Sheets—The Ancient Way.

Coppersmiths shaped utensils of the metal by hand from the earliest times and even made chariots of the metal twenty-five hundred years ago. The fashioning of things from copper had been handed down from father to son from the dawn of civilization, these men being in fact directly descended, if not by blood, then by training, from the old coppersmiths pictured in the Egyptian temples. This handcraft was jealously guarded by members of the craft and apprentices worked for years to learn the business which included many technicalities of operation and had a language of its own. The fashioning of objects from copper was still a handcraft up to the time of the invention of copper spinning by Hayden, of Connecticut, in 1851. In the early days of the American industry, workers in copper were imported from England and at that time refused to teach others the craft and demanded to be kept in closed shops where their operations could not be seen.

Today, copper sheets are made by passing one of the products of the refinery, the so-called copper "cakes" through rolls. The cakes are heated in a furnace and are then run between several sets of hot rolls where they are partially flattened to size, after this, the flattening process is completed by passing through another set of rolls where the metal is cold rolled. This is the oldest mechanical operation and takes the place of the ancient pounding with a stone to produce a sheet.

Copper is very ductile, that is, it can be drawn out or formed into wire. The wire is made from bars formed at the refinery called wire bars. The bars are placed in a heating furnace and heated until they

Fig. 5—Making Copper Sheets—The Modern Way.

reach a temperature of about 750° C., when they are conveyed to the rolling mills and sent through the grooves of the rolls, thereby being reduced in diameter and lengthened at the same time. From the first rolls called the roughing rolls the bars pass to the intermediate and then to the finishing rolls, where they are guided through all the various passages cut in the rolls. They are rolled smaller and smaller with each operation until finished as rods when they are wound on reels. They then go to the wire-drawing machines where the rods are pulled through a series of dies each one smaller than the last. Copper wire can be drawn as fine as 1/1000 of an inch in thickness and some sizes of wire are regularly made in mile lengths.

Rods and wires are also made by the extrusion process. In this method short bars or billets of copper are placed in a large hydraulic press where a plunger forces the bars while hot through dies that can be shaped for wire or for rods, or have any special shape desired.

Copper tubing is made by a process somewhat similar to the extrusion process. Billets are again used and after being heated and formed, are placed in the piercing mill where they encounter a steel point carried on a long rod. They are forced over this point by rollers that give the heated billets a powerful forward motion forcing them into somewhat thick and irregular-shaped tubes. The irregular tubes are then drawn through dies, where the plug for forming the inside is fastened to a long rod. As the tubes are drawn through the dies, the tubes become smaller in diameter and the walls become thinner until the finished tubes are produced.

During the last few years seamless, and endless tubes of copper and other metals have been made by electrolysis. The method of forming the tubes at first was to deposit the metal from solution onto an iron core alloy by means of the electric current. The metal sheath was pulled off of the iron core alloy as it was deposited from the solution. But this method was too slow; only a few inches of tubing could be made in an hour. So a second method was devised, using a lead core which moved continuously through the solution, metal depositing in the same manner as it did on the iron core. Then the lead core is melted away, leaving a tube of copper or other metal as the case may be. A tube five yards long and nearly one-tenth of an inch thick can be made in twenty-four hours.

Another important property of copper is its tensile strength, that is, it withstands elongation to a great degree when a pulling force is exerted upon it. It is an excellent conductor of heat and electricity

being inferior only to silver which ranks first in these two properties. It is not a very hard metal, having a scratch hardness of 3.7 compared to silver at 2.7 and iron at 4.5. Copper can be distilled in the electric furnace. The color seen when it is heated in the Bunsen flame is green, and the darkening noted on the surface of the metal during heating is due to the formation of cupric oxide. Dry air has very little if any action on copper but in moist air with carbon dioxide present, it becomes coated with a basic carbonate of copper, green in color, sometimes called "verdigris." The word verdigris was derived by the corruption of two Latin words, viride, meaning green and aeris through aes meaning copper or brass. The word verdigris is also used as a common name for the basic acetate of copper. When air is excluded, copper is not dissolved by diluted acid but it is soluble in concentrated acids; however, by means of heat and excess of air, it is dissolved even by dilute acetic acid. Copper is dissolved by many saline solutions and also by ammonia water if shaken with air or oxygen. It is precipitated from solutions of its salts by the more active metals such as iron and in turn being more active than some other metals, for example silver, precipitates silver from solutions of silver salts. In other words, an iron nail or other form of iron placed in a copper solution will cause copper metal to precipitate and copper metal placed in a solution of a silver salt will cause the silver metal to separate. In the latter case, the separation of silver can be readily shown by placing a small piece of copper wire on the slide under the microscope and then dropping silver nitrate solution on the wire. Silver will separate in patterns resembling the branches of trees.

Copper has many, many uses. Because it conducts heat to such a high degree, roasts run through with skewers made of nickel-plated copper are not only juicier, more tender, and more appetizing than those baked in the ordinary way, but they also require 30 per cent. less time for cooking. This culinary discovery is explained on the grounds that the copper serves to carry heat into the interior of the roast evenly and rapidly while meat fiber alone has a very low heat conductivity.

Copper, an excellent conductor of electricity, is largely responsible for this electrical age of ours. About 55,000,000 pounds of it are used each year in making wire for electrical installations. A hundred million miles and more of copper wire connects the user of the telephone with many of the other countries of the world. The present wire

mileage of the one large telephone system of the United States is 75,000,000 miles.

Copper tubing is used in making cores for radiators of automobiles and for their gasoline lines. Tubes or pipes are used also in coils for heating water and in distilling apparatus. Pipes for the water systems of the modern home can now be had of copper. These pipes have a number of advantages over iron pipes; they will not rust; they can be bent around corners, and they will withstand freezing strains that bursts pipes of other materials.

Ready built houses the exterior parts of which are entirely of copper are now being built in Germany; this type of house may soon be seen in the United States, for a patent has been taken out in this country covering the manufacture of a portable "knockdown" house composed of metal units.

Nails of copper are being used in some of the modern construction work, for materials put together with nails of this kind means building for permanency. The famous Rose Bowl of Pasadena, California, where Southern California plays football, required two tons of copper nails for its construction. In this amphitheater, all of the seats were constructed of a very fine quality cedar, and in fastening this wood in place copper nails were used. Heads of these nails will not rust off and allow boards to become loose, nor will there be any rust to spot the clothing of the seat's occupant.

Radiators, the heat distributors of the home, are sometimes made of copper. The Waldorf-Astoria Hotel of New York City has radiators of this metal in which 80,000 pounds of copper were used.

The roofs of many buildings are made of copper. Roofs of this metal are permanent; when weathered they are a beautiful green color, and when properly grounded, they serve as a protection against lightning. A copper roof protects the Capitol building at Washington, D. C. Gold is even giving way to this baser metal, and the gold dome on the top of the Library of Congress building is soon to be replaced by a copper dome. Shingles are made of copper; they are light in weight, fire and waterproof, and very durable. Lightning rods and conductors of this metal are very lasting and serviceable. For those who do not like the green color of weathered copper, lead-colored copper (sheet copper surfaced with lead) is available for construction purposes. Roofs and vertical surfaces can be finished of this material in tones of color which can be varied from a bright metallic gray to an antique gray. Lead-coated copper is extremely ductile and is easily

worked into intricate shapes and designs. One of the landmarks of New York's financial district, the Bank of the Manhattan Company, is roofed with lead-coated copper, more than 120,000 pounds being used on this building.

Copper sheathing is being used for facing filling stations and it has been used for covering the wooden bottom of ships to protect them from sea water rotting and also to inhibit as far as possible the collection of marine growths.

Copper is used to make various kinds of utensils used for culinary purposes; tubs for washing machines; hot-water boilers; evaporators and kettles. Copper utensils should always be kept bright and well polished, because tarnished utensils may contaminate foodstuffs, making the food unft for human consumption.

All electric motors use copper in their construction. Ether for anesthesia is now put up by a certain American manufacturer in copper-lined cans because cans of this type seem to prevent decomposition of the ether stored in them.

U tubes made of copper, used for the isolation of fluorine, have supplanted the costly platinum-iridium tubes originally used. An uncommon and interesting use for copper is in the making of bracelets to be worn on the arms of people troubled with rheumatism.

Copper melted with other metal is widely used, and the solids resulting, called alloys, usually have a very definite set of properties, different from the parent metals as to color, hardness, melting point and field of usefulness. The two alloys of copper most widely known and used are bronze and brass.

The using of bronze for various purposes by the ancients has led historians to call a certain period of civilization the "Bronze Age." This age is applied to that stage of human culture during which the alloying of tin with copper became a widespread practice, and the material thus obtained was used for tools and weapons as a supplement to or a substitute for stone. The word "bronze" is probably derived from the first part of the name of the city of Brondeism (now called Brindisi), located at the back of the heel of Italy, although it might have been derived from bruno, the word for brown. The Bronze Age marks the beginning of historic times, for, roughly speaking, man began to leave written records about the time of the discovery of bronze. This age lasted from about 4000 to 1500 B. C. in Asia and from about 2000 to 1000 B. C. in Europe.

From time to time archaeological expeditions in different parts of the world have unearthed many objects of bronze along with pottery and other articles used by the ancients. About a year ago such a find was made in Mesopotamia. Particular interest was attached to the pottery, for it preceded the bronze work in age and pointed to a time in the history of this country when a state of comparative ease existed. This leisure subsequently seems to have been driven out by the advent of metal, for the coming of bronze speeded up the mode of living and the painted pottery gave way to things of a more utilitarian nature. Another find in East Pomerania of an ancient spiral bronze brooch points to an opulent period in that country when objects of bronze satisfied the longings of the ancient flappers for ornaments. The brooch was two feet long and more than twenty-three feet of bronze had been used in its making.

Discharge papers of a Roman soldier, recently presented to a British museum, were two bronze plates hinged together by three rings forming a kind of folder. The soldier in this instance quitted the service of the Emperor Hadrian in 122 A. D.

History has many examples such as these showing the effects and uses of this interesting alloy in the past centuries, linking ancient civilizations with the civilization of today, for bronze still has its uses in this world of ours.

Ordinary bronze consists of about three-fourths copper and one-fourth tin, but there are many bronzes which contain besides these two elements varying proportions of many of the other elements. For instance, the cent piece of the United States coinage contains besides copper and a small percentage of tin (¾ per cent.) a small amount of zinc (½ per cent.). Our cent is really a bronze coin. Sea water bronze consists of copper, nickel, tin, zinc, and bismuth. Phosphor bronze is an alloy containing copper, tin, and bronze.

There are many other bronzes, such as metal bronze, bearing bronze, gun metal bronze, hardware bronze, chain bronze, bell metal bronze, and speculum metal bronze. The uses can be told from the names of the bronzes in all cases except perhaps in that of the speculum metal which is used for making the reflectors of telescopes and other instruments. Some other bronzes are: Tobin bronze, an alloy used for making piston rods, propeller shafts, nuts, bolts, and plates; aluminum bronze, a yard, yellowish-brown alloy, non-corrodible, light and strong, used for ornamental purposes and for the hulls of yachts; manganese bronze, used especially for making ship propeller blades

of great wear resistance; statuary bronze, an alloy which can be worked with the chisel or cast, used in the making of artistic objects, because when cast it readily reproduces every detail and has the property of readily becoming covered with a greenish layer of carbonate of copper which renders it similar to antique bronze; and commercial bronze, used in the manufacture of window screen wire, radiators and ornaments. The last named is really not a bronze, but a red brass consisting of 90 per cent. copper and 10 per cent. zinc, no tin.

The name brass in its older use was applied rather to alloys of copper and tin now known as bronze. The brass of the Bible was probably bronze, and so was much of the brass of later times until the distinction between zinc and tin became clearly recognized. One of the earliest examples of brass was a Roman coin of 20 B. C. Brass was manufactured in England in the sixteenth century, for Queen Elizabeth granted the patent right to make brass to some manufacturers during that century.

Ordinary brass in an alloy of about two-thirds copper and one-third zinc, although, as in the case of bronze, various proportions of many other elements are added, producing many different kinds of brasses. One kind of brass is called "high brass," of which there are three qualities: common high brass, bright yellow in color and very ductile, used for ordinary drawing and forming purposes, consisting of about 65 per cent. copper, 34 per cent. zinc, and small quantities of iron and lead; extra quality high brass, which contains about 2 per cent. more copper and 2 per cent. less zinc, recommended for good quality springs and for spinning.

The spinning of metals is a process in which thin sheets or pieces of metals are placed upon a wooden model shaped like the article to be made; the model is made to rotate in a lathe, burnishers and other tools being employed in the practice to press the yielding metal into all the curvatures of the model, so that finally the article desired is turned out in metal.

The third of the high brasses is the "best quality." It contains about 5 per cent. more copper and 5 per cent. less zinc than the common high brass and is used for making eyelets and cartridge cases.

Besides the high brasses, copper and zinc form two low brasses. Low brass itself, made up of about 80 per cent. copper and 20 per cent. zinc, an alloy of light golden color, very ductile, used in the manufacture of band instruments and wire cloth for paper mills. The second kind, known as rich low brass, is about 85 per cent. copper and 15 per

cent zinc. It has a fine golden color, is very ductile and is used for imitation jewelry and other articles where a golden color is desirable.

Dutch metal or imitation gold leaf is an alloy of copper and zinc; in fact, a brass.

There are 35,000 articles of convenience for the household made of brass. In buying brassware, solid brass articles should be purchased, for they will not rust and become unsightly. Many articles today are only plated with brass, and often the plating is on iron, a metal easily rusted. Brass (and bronze) plated ironware can easily and quickly be told from solid brassware by using a magnet. The former attracts the magnet, while with the latter there is no attractive force noted. Even in the case of pins, some are steel, others are coated brass. They look alike, but the steel pin rusts and garments fastened with it may be torn, due to jagged edges produced from the rusting, but with the brass pin this never happens. The pin of steel can also be told by the magnet, to which it is attracted, while the coated brass remains at rest.

In addition to the alloys of brass and bronze there are many other alloys in which copper is an important constituent. All American coins are alloys containing this metal, although the bronze cent is the only one which really shows visible evidence of copper; gold and silver coins contain 10 per cent. of copper in order to harden them for gold and silver alone are too soft to resist wear. The five-cent piece is an alloy of nickel and copper. Sterling silver is 92.5 per cent. silver and 7.5 copper. This is standard for the British silver coinage and silver plate. Silver ornaments made from standard silver can be heated to oxidize the copper near the surface, and if the resulting copper oxide is removed by digesting with acid, a superficial layer of pure silver is left, producing the so-called "frosted silver."

German silver, an alloy of copper, zinc and nickel, no silver, was originally obtained from old copper slag in Henneberg, Germany. German silver, also called Liberty silver or nickel silver, is used for the better grades of articles which, when finished with nickel or silver plate, remains white even after the plating wears off. It finds its greatest use in the manufacture of tableware, high-grade plumbing fixtures and automobile trimmings.

Sheffield, England, famous as a city of steel, is now turning its attention to the production of an artificial gold in which copper and aluminum are alloyed. Successful experiments have been made in

casting the alloy of these two metals which has the appearance of gold and is being made to imitate various shades of gold alloys. The new material is stainless and can be washed with alkaline solutions. A full dinner service in this alloy has been made which is not very costly.

Ancient methods of hardening copper are frequently referred to as among the lost arts, but even if this statement were true the rediscovery might be of little value in view of the recent progress in hardening and strengthening copper by alloying it with small amounts of other elements. Everdur, a patented product, is such an alloy. It contains silicon and manganese besides the copper, different proportions of these elements being present in the cast and wrought forms of the alloy which combines strength approaching that of steel with the non-rusting corrosion resistance properties of copper. This material may be worked either hot or cold, machines well, can be welded either by oxy-acetylene or the electric arc, and may be brazed or soldered. It is used in making pump linings, pipes, valves, wire screens, and the like. Tempaloy, another alloy of similar nature, which has different properties at different temperatures, is made by alloying silicon and nickel with copper.

Monel metal, one of the most interesting alloys of nickel, contains about 35 per cent. of copper, but since it is a white alloy, the fact that considerable copper is present in this material may be lost sight of.

Besides the many alloys in which copper plays an important role, it also enters into definite chemical compounds, forming substances which have a variety of colors and uses. Copper heated to a red heat in air combines with the oxygen present to form a black compound, cupric oxide, used as a reagent in chemical analysis. By heating cupric oxide to 1026 degrees C. and higher, cuprous oxide, a red compound, is formed. This red compound is used to some extent to color glass red. Both cuprous and cupric oxides are insoluble in water, but when treated with acid, for example, hydrochloric acid, yield, respectively, cuprous and cupric chlorides, the former a white powder, the latter yellow to greenish blue in color, depending on the method of preparation. Since copper combines with two different amounts of oxygen or chlorine as it does in the compounds just mentioned, chemists classify not only the oxides and chlorides but all the compounds of copper as either the "ous" or "ic" forms. The "ous" compounds have copper present in a greater proportion by weight than the "ic" compounds. They are usually white in color, unstable in air, and insoluble in water.

The "ic" compounds, the commoner of the two classes, are generally blue or green in color and fairly stable in air. The common "ic" compounds such as cupric chloride and cupric sulphate (bluestone) are soluble in water. When a solution of cupric sulphate is treated with caustic soda (sodium hydroxide) solution, cupric hydroxide, a blue precipitate is formed. Cupric hydroxide may be formed in other ways, one common method used on the farm especially is to mix the cupric sulphate solution with milk of lime; the product so formed is known as Bordeaux mixture, used to spray grapevines and plants to combat the fungi which grow on them. The specific substances present in Bordeaux mixture are in doubt; some believe cupric hydroxide and calcium sulphate are present, while others believe basic copper sulphate is formed. At any rate, this mixture was the remedy used in the past to save from destruction the wine industry of Southern France and the coffee industry of Java.

The effect of this mixture was discovered by accident in 1882, when Professor Millardet of the Faculty of Sciences, Bordeaux, France, in passing through a vineyard, noticed that some of the vines retained their leaves while elsewhere they had fallen. In searching for the reason for this condition he was informed that the grape leaves which remained on the vines had been covered with a mixture of copper sulphate and lime to keep away marauders, who were afraid to eat the grapes for fear of this mixture. All the leaves had not been covered, but only those around the border of the vineyard; thus the effect of the treatment had been very noticeable.

Cupric hydroxide, although nearly insoluble in water, is soluble in ammonia, and this deep blue cuprammonium solution, known as Schweitzer's reagent, has the property of dissolving cellulose materials such as cotton and filter paper. One kind of imitation silk, the cuprammonium variety, is made by dissolving purified cotton in a cuprammonium solution and subsequently forcing this cotton solution through capillary openings (spinnerets) into a bath of acid or alkali when the cotton is thrown out of solution in the form of fine threads. The cuprammonium reagent is usually prepared on a large scale by exposing thin sheets of copper in cylindrical towers to the combined action of concentrated ammonia water and air.

Cupric sulphate, known commonly as bluestone or blue vitriol, and mentioned as one of the ingredients of Bordeaux mixture, is the most important compound of copper. It is prepared generally by roasting copper sulphide just enough to form the sulphate, which is in

turn extracted with water yielding a solution from which the blue compound can be obtained by crystallization; or copper oxide may be made by sufficient roasting of the sulphide and by dissolving the oxide in sulphuric acid, cupric sulphate is produced. Thus, the sulphate is, often obtained in large quantities as a by-product in handling the sulphide ores of copper. Some of the uses of cupric sulphate are in the manufacture of colors for calico printing, in various spray mixtures, in electroplating and in electrotyping. The electrotyping process is based upon the fact that metallic copper may be deposited in tough, smooth films of extreme thinness on suitably prepared surfaces by the flow of a direct current of electricity under the proper conditions. In the process, type is first set up for a page of a book and an impression is made in wax from the type. The impression is then covered over with finely powdered graphite to give it a conducting surface and is used as an electrode (cathode) immersed in cupric sulphate solution containing a trace of gelatin or glue. A heavy plate of copper is used as the other electrode (anode) and as the electricity flows between the electrodes, copper deposits on the graphited wax surface to about the thickness of a sheet of paper. The last step in the process is the stripping away of the copper deposit from the wax and filling in of the back of the copper page, as it were, with melted lead to strengthen it. Text-books are commonly printed from the copper pages (electrotypes) so produced.

Electroplating or plating by means of electricity is somewhat similar to electrotyping in principle, the main difference being that a plate of the metal to be plated, such as iron, is substituted for the graphited wax electrode. Cupric sulphate is used in like manner as in electrotyping if copper plating is going to be done. But in the case of iron, plating directly from a cupric sulphate solution produces an inferior coat of copper, which has a tendency not to adhere to the metal base, so that another compound of copper, the cyanide, is used in the initial plating of the iron. After this plating, which is really carried out in a copper sodium cyanide bath, plating is continued in the cupric sulphate solution. If a bronze or brass plating solution is required, zinc cyanide is added to the copper sodium cyanide bath.

A very interesting use for cupric sulphate is in the soil treatment of the muck of the Florida Everglades. The raw sawgrass soil of this region, upon which nothing could be grown but potatoes, has, by treatment with this important chemical been made fit for the growth

of other crops such as sugar cane and peanuts. A diet of the copper salt alone did not entirely satisfy the peanut, so that zinc sulphate was added. The peanut plants grew much better on the soil treated with the two sulphates.

The United States exports cupric sulphate to other countries, and in the first ten months of 1931, 3109 short tons, valued at $249,000, or about $80 a ton, were shipped from our shores.

Another common compound of copper is Paris green, prepared by heating basic copper acetate (verdigris) with a solution of arsenious acid containing acetic acid. This green powder, which is a copper aceto-arsenite, is used on plants to combat leaf-devouring insects such as the Colorado beetle (potato bug) and the Japanese beetle. Another green is Scheele's green, a copper arsenite.

Cupric ferrocyanide, a chocolate-brown solid, makes an ideal membrane for osmotic pressure measurements.

Copper compounds are needed by young oysters to make them settle down and grow up. When an oyster first hatches from the egg, it lives for a couple of weeks as a free swimming larva. At about two weeks of age it is ready to settle down to grow to adult size, but does not do so unless it receives a dose of a few molecules of copper. One part of copper in fifty million parts of water is enough to cause the young oyster to forsake a roving life and become a fixed citizen of the oyster commonwealth. Copper in nature is brought to the ocean from the fresh water streams which have in turn dissolved it from the soil through which they have traveled.

Some humans also need copper, for it has been found that people suffering from pernicious anemia really lack copper. In the treatment of this disease liver seems to be the only diet which furnishes enough copper to be beneficial. Of course a liver diet finally becomes disagreeable, so experiments were carried out to increase the copper content of milk so that it could be used by the anemics. Cows and goats were fed copper-containing diets, but the milk from these animals showed no increase in copper over what is normally present, so that liver is still the main article of diet.

Copper is now (in the early part of 1932) selling at about 6 cents a pound, the lowest price in all history. In July, 1864, copper sold at 59¾ cents a pound, and from that time on the market price has gradually dropped. Ordinarily copper can be marketed at a profit at 10 cents a pound, but with metal from the Belgian Congo selling at 5

cents on the New York City docks, American copper mines are about to shut down. In Nevada the net cost of producing copper in the last quarter of 1931 was a little over 7 cents a pound. Can American producers compete with competitors having cheap African labor available?

The production of copper in the United States as late as 1845 was only 100 tons a year. In 1930 the copper production of this country was 820,000 short tons, representing 46 per cent. of the output of the world. The world production of the metal in 1930 has been estimated at 1,806,642 short tons.

According to experts, there is a bare twenty-year reserve of copper within the confines of the United States, with no synthetic process for the production of this metal.

Copper, one of the six raw materials of major importance in international human and industrial needs—the others are coffee, nitrate, petroleum, rubber, and silk—is today one of man's most useful metals if not the most useful of them all.

THE VOLATILITY OF TINCTURE OF IODINE*

By J. G. Roberts, Ph. M.

THREE of the four substances entering into the composition of Tincture of Iodine U. S. P. are volatile at ordinary temperatures. Alcohol boils at 78° C., and water at 100° C. Iodine fumes at about 114° C., and gradually vaporizes in the form of violet fumes. All of these however are partially volatilized at much lower temperatures. Potassium iodide is ordinarily stable and is not volatilized until it has been heated to a temperature of about 720° C. In view of these facts the question arises as to which of these substances is the most readily volatilized from solution.

As odor is the sensation produced by the action of volatilized principles upon the olfactory nerves, it would appear that iodine is the most volatile of these, as the odor of that substance is decidedly the most pronounced. This is also indicated upon heating a portion of the tincture upon a steam bath when dense purple fumes of iodine are produced.

With the foregoing facts in mind a series of experiments were conducted to determine whether Tincture of Iodine increases or decreases in iodine content when exposed to the atmosphere. Accidental exposure does possibly occur at times and may be due to the storage of the container in too warm a place thereby causing increased pressure and the consequent loosening of the stopper. A contraction of the cork stopper after long exposure to the iodine is also a contributing factor.

The experiments were conducted upon 50 cc. accurately measured and weighed samples placed in wide mouth flasks and exposed to the atmosphere for two, four and seven days respectively. Upon analysis the sample used was found to contain 3.503 gms. of iodine and 2.585 gms. of potassium iodide in 50 cc. Its alcoholic content was 81.45% and the specific gravity .9380 at 25° C.

The following table shows the results obtained:

Length of Exposure	Sp. Gr. at 25° C.	Amount Vaporized	Alcohol Vaporized	Alcohol Content of Remainder	Iodine Vaporized	Iodine in Remainder Calculated on 50 cc. Basis
2 Days	.9610	9.13 cc.	8.029 cc.	80.00%	.1133 gm.	4.147 gms.
4 Days	.9838	15.07 cc.	13.427 cc.	78.15%	.1422 gm.	4.796 gms.
7 Days	1.0108	21.00 cc.	18.845 cc.	75.45%	.2312 gm.	5.641 gms.

*Presented to the Pharmaceutical Association Convention at Wernersville, Pa., June 21-23, 1932.

These results show a decided loss in volume as there was only 29 cc.. remaining of the original 50 cc. used. The loss is largely that of alcohol which shows an increased loss after each exposure and a decrease in the alcoholic content of the remaining portion. A progressive loss of iodine is also noted, but on account of the greater loss of alcohol a decided concentration of iodine occurs. The tincture originally containing 3.503 gms. of iodine in 50 cc. then contains 5.641 gms. of iodine calculated on the 50 cc. basis.

Exposure of Tincture of Iodine to the atmosphere causes a loss of alcohol and iodine. The rate and amount of loss depending upon temperature, length of exposure and width of the neck of the container. The experiments described herein show a loss after seven days exposure of 46.27% of the alcohol and 6.6% of the iodine originally present in the tincture.

SMITH, KLINE & FRENCH LABORATORIES.

MEDICAL AND PHARMACEUTICAL NOTES

NEW ISOTOPES PREDICTED WITH NEUTRONS AS "BRICKS"—Cobalt of atomic weight 57, manganese of atomic weight 53, and vanadium of atomic weight 49 are predicted by Dr. James H. Bartlett, Jr., young American physicist and fellow of the National Research Council, through the use of a new theory of atomic structure in which neutrons and protons only are used as building blocks of the nucleus.

The normal atomic weights of cobalt, manganese and vanadium of the sorts now known are 59, 55 and 51, respectively. Atoms of different weight but having identical chemical behavior are known as isotopes.

The neutron was identified as an entity only a few months ago. It is a close combination of an electron and a proton. Older theories of atomic structure considered the hearts of atoms as built of protons and free electrons, but the discovery of the neutron has led to the theory that electrons occur within the nucleus only as parts of neutrons. Starting with a helium nucleus and adding alternately a neutron and a proton, Dr. Bartlett obtains all the elements in the chemical table up to oxygen of atomic weight 16, namely, lithium 6 and 7, beryllium 8 and 9, boron 10 and 11, carbon 12 and 13, and nitrogen 14 and 15. Beyond oxygen, owing to a change in the arrangement of the "bricks" within the inner shell (two neutrons being more stable in the central field than a neutron and a proton) the order of addition becomes: neutron, neutron, proton, proton, and repeat. This gives oxygen 17 and 18, fluorine 19, neon 20, 21 and 22, sodium 23, magnesium 24, 25, 26, etc.—(*Science News.*)

PEPSIN AND RENNIN—The ability of gastric juice to clot milk has been ascribed by Hammarsten to a special proteolytic enzyme, chymosin or rennin. The Pavlov school and others, however, have long maintained that there is no necessity of attributing rennet action to a special organic catalyst. This view was seemingly supported by the well-known fact that practically all proteolytic enzymes, even those from vegetable sources such as papain from the melon tree, can effect

the clotting of milk. In his last contribution to this subject, in 1923, Hammarsten concluded that there was no positive proof against identity of pepsin and rennin.

Recently Kleiner and Tauber* have reported the isolation in comparatively pure form, of a rennin preparation from the mucosa of the fourth stomach of the calf. This preparation shows the highest clotting power yet reported; at the same time it is practically devoid of peptic activity. The elementary composition, and the properties of the preparation indicate that it is a thioproteose. Unlike pepsin, it contains neither chlorine nor phosphorus. The authors state that it differs from pepsin in other ways. Rennin is irreversibly inactivated by alkali, it is easily soluble in dilute acid, it is not coagulated by heat, it gives quite different protein color tests, and it is not dialyzable. Moreover, its iso-electric point is pH 5.4, while that of pepsin is 2.75, and it is soluble in water at its iso-electric point, whereas pepsin is not. In addition, the New York investigators have shown that the enzyme is present in the mucosa in the form of a precursor that becomes activated, as does pepsinogen, by hydrochloric acid. The zymogen differs from the active enzyme in that it is completely destroyed by contact with 50 per cent. alcohol. Efforts to obtain rennin in crystalline form, as has been accomplished for urease, pepsin, trypsin and amylase, are yet unsuccessful.

The contribution here discussed marks a distinct advance in our knowledge of the chemistry of the digestive enzymes, a field opened by the discovery of the starch-splitting power of saliva by Leuchs a century ago.—(*J. A. M. A.*, Vol. 99, No. 10, p. 834.)

ABSTRACTS OF PAPERS PRESENTED AT THE SCIENTIFIC SECTION OF THE AMERICAN PHARMACEUTICAL ASSOCIATION (1932 Meeting).

The Bactericidal Efficiency and Toxicity of Creosote and Its Components. Louis Gershenfeld, Ralph Pressman and Horatio C. Wood, Jr.

1. Creosote is an active bactericide. The phenol coefficients of seventeen samples ranged from 2.2 to 3.9 for both Bacillus Typhosus and Staphylococcus Aureus, with an average of 3.0.

*Tauber, Henry, and Kleiner, I. S.: Studies on Rennin: I. The Purification of Rennin and Its Separation from Pepsin, *J. Biol. Chem.*, 96, 745 (June) 1932; II. The Isolation of Prorennin, *Ibid.*, 96, 755 (June) 1932.

2. Both guaiacol and creosol are less than half as powerfully bactericidal as creosote.

3. No reliable criterion of bactericidal power was observed in any physical property, but the high boiling fractional distillates (215°-220°) were the most efficient.

4. The minimal lethal dose for the guinea pig of either creosote or guaiacol is about 0.55 cc. per kilo intraperitoneally. The high boiling fractions are less toxic than those distilling below 210° C.

5. The dimethyl-phenols (Xylenol) and ethyl-guaiacol are more active bactericides than either creosote or guaiacol. It is suggested that the antibacterial efficiency of the high boiling fractions of creosote is due largely to these compounds.

6. Propyl-guaiacol (coerulignol) and butyl-guaiacol are very efficient against the typhoid bacillus, but decidedly less active than creosote against Staphylococcus Aureus.

7. We believe the quality of creosote would be improved by raising the temperature at which it begins to distill, above the present pharmacopœial requirement.

An Assay Procedure for Camphorated Tincture of Opium U. S. P. A. R. Bliss, Jr., E. D. Davy, R. W. Morrison, N. T. Chamberlin, A. J. Schwarz, R. I. Granthem and W. H. Blome.

This is a method developed by Dr. A. R. Bliss, Jr., Chairman of the Group Committee on Opium Assays (Revision Committee of the U. S. P. XI), and collaborators. In the hands of seven collaborators the method yielded remarkably close results, the difference between the highest and the lowest average values obtained being but 0.00370 gm. of anhydrous Morphine per 100 cc. of Camphorated Tincture of Opium. The method consists of acidifying 100 cc. of sample with N/2 Sulphuric Acid, evaporating to small bulk, removing to a separator, adding Sodium Chloride, and neutralizing with stronger ammonia water. Then shaking out with Chloroform-Alcohol, transferring to a second separator, adding alkaline salt solution, and extracting the Morphine with alkaline salt solution and removing the combined alkaline salt solution to a third separator. Then adding a slight excess of Hydrochloric Acid, cooling, shaking with Chloroform, removing the Chloroform to a fourth separator, shaking it with acidified saturated salt solution, discarding the Chloroform in the fourth separator, and adding the acid salt solution to the contents of the third separator. Then adding stronger ammonia water to the third sepa-

rator in slight excess, cooling, and immediately extracting the Chloroform-Alcohol, filtering the Chloroform fraction which is evaporated to very small bulk, diluted with neutral alcohol, heated, acidified with 0.02 N. Sulphuric Acid, deprived of alcohol by heating, cooled, diluted with distilled water, and the excess of acid titrated with 0.02 N. Sodium Hydroxide, methyl red being used as the indicator.

The Effect of Various Compounds Upon the Stability of Hydriodic Acid. Wm. J. Husa and Louis Magid.

The effect of various iodides upon the rate of decomposition of hydriodic acid was as follows: (a) marked acceleration, Fe $\pm\pm$, Mn^{II}, Sr; (b) appreciable acceleration, Na, K, Li; (c) slight acceleration, Mg, Ca, NH_4; (d) slight retardation, Zn, Cd; (e) marked retardation, Ba, Hg^{II}. With constant pH an increase in iodide concentration increases the rate of decomposition, and with constant iodide concentration, the rate of decomposition increases with increasing hydrogen ion concentration. The effect of various salts on the rate of decomposition of HI was: (a) marked acceleration, $NiCl_2$, $FeCl_2$ and $CoSO_4$; (b) no effect NH_4Cl and LiCl; (c) slight retardation, $MnSO_4$, $MgCl_2$, $BaCl_2$, $ZnCl_2$, KCl and NaCl; (d) marked retardation, $Al_2(SO_4)_3$ and $CdCl_2$. Ni + +, Co + + and Fe + + appear to have a specific catalytic effect. The retarding action of Cd and Al salts may be correlated with the known tendency toward formation of complex ions.

The Antiseptic Value of Phenol Ointments. Wm. J. Husa and Jeannette M. Radin.

The effect of variations in the base on the antiseptic value of phenol ointments was studied, using the Reddish test. Tests made on 5% phenol ointments containing water, anhydrous lanolin and petrolatum showed that the presence of small proportions of water is unimportant, but that the relative proportions of anhydrous lanolin and petrolatum is the deciding factor in determining the antiseptic properties, good zones being obtained when the per cent. of anhydrous lanolin in the base varied from 23 to 25.5%. Although U. S. P. X Ointment of Phenol shows no antiseptic properties by the Reddish test, the following ointment shows very good antiseptic properties by the same test: Phenol 2 gm., wool fat 24.5 gm., petrolatum 73.5 gm. The addition of five per cent. of yellow wax to this formula reduces the antiseptic power to zero. Tests were also made with other ointment bases.

NEWS ITEMS AND PERSONAL NOTES

LaWall's Four Thousand Years of Pharmacy Translated to Japanese—The epic historical volume by Dr. Charles H. LaWall, Dean of the Philadelphia College of Pharmacy and Science—"Four Thousand Years of Pharmacy"—which has won world-wide approval since its publication, has just been issued in a Japanese translation. This work has been published by Kosei Kaku Publishing Company, Tokio, Japan.

The translation was made under the direction of Iwao Hino of Ayabe, Japan, with the expert assistance of Professor Totaro Shimizu, one of the leading professional pharmacists of Japan.

Ambrose Hunsberger Succeeds Colonel Wynne as Tristate Prohibition Director—Ambrose Hunsberger who, for a number of years, has conducted a professional pharmacy at 1600 Spruce Street, Philadelphia, Pa., and for some time past has been connected with the United States Bureau of Industrial Alcohol, was recently appointed Supervising Director of Alcohol Permits, for New Jersey, Pennsylvania and Delaware, succeeding Colonel Samuel O. Wynne.

Mr. Hunsberger is a former President of the N. A. R. D., and is at present Chairman of its Executive Committee. He is a member of the Board of Trustees of the Philadelphia College of Pharmacy and Science and Secretary of the College.

Mallinckrodt in Chicago International Exposition—The Mallinckrodt Chemical Works of St. Louis, Missouri, in addition to having taken large space for a commercial display, is sponsoring an exhibit in the electro-chemical section of the chemistry division at the 1933 "A Century of Progress" International Exposition at Chicago.

This exhibit which has already been constructed, shows the growth and development of metallic crystals of lead, tin, and cadmium.

It is now in the Basic Science Laboratory in the Administration Building, pending its removal to the Great Hall of Science, where it will be on permanent display during the Exposition. The Hall of Science was recently completed and dedicated, but as yet, none of the permanent displays have been removed to it.

The Administration Building where the Mallinckrodt exhibition is situated is open to the public and visitors are cordially invited to inspect the various displays.

PARKE-DAVIS HALIVER OIL PLAIN NOW AVAILABLE—On September 1, Parke, Davis Company announced a second Haliver Oil product, Haliver Oil Plain. As the name implies, the new product consists of halibut liver oil without the addition of Viosterol. It will be recalled that Haliver Oil with Viosterol-250 D was introduced in January of this year and has been extensively prescribed by the medical profession since that time.

Haliver Oil Plain is being put on the market in response to a demand for a preparation containing an exceptionally high concentration of vitamin A in the smallest possible bulk. Parke-Davis Haliver Oil Plain has a natural vitamin A potency 100 times greater than that of high-grade cod-liver oil—a vitamin A potency greatly exceeding that of any vitamin preparation heretofore available. In addition, it has a natural vitamin D potency fifteen to twenty times that of cod-liver oil.

The new product is supplied in 10-cc. vials and 3-minim capsules, fifty to the box.

So far as Haliver Oil with Viosterol-250 D is concerned, it is expected that this product will be more widely prescribed than ever during the coming fall and winter. Because it contains both vitamin A and D in highly concentrated form, this product is logically indicated wherever cod-liver oil or Viosterol has been used in the past.

FOURTH ANNUAL RAGWEED POLLEN SURVEY—The fourth annual national ragweed pollen survey conducted by O. C. Durham, Botanist of the Abbott Laboratories, with the co-operation of the U. S. Weather Bureau, will begin on August 10. Ragweeds are

just beginning to pollinate. Within a week pollen clouds will be forming. The progress of the season, its local and national severity, and factors influencing the behavior of the invisible misery laden pollen clouds will be studied from all angles. Daily measurements of the ragweed pollen content of the air will be conducted in thirty-six cities in the United States and five in Canada.

Besides the usual daily measurements of pollen in various cities, upper air studies will be conducted by means of airplane exposures at the Chicago Municipal Airport. These records will be made at 1500 feet altitude.

Nineteen thirty-one was one of the most severe hay-fever years ever experienced. The combination of favorable growing weather in most parts of the United States and favorable weather during the season of distribution caused untold suffering among the hay-fever victims who had not been previously immunized by pollen treatments. Records of rainfall during July, 1932, seem to indicate that in general the season will not be as severe as last year, although in some places it will doubtless be more severe.

Cities included in National Ragweed Pollen Survey 1932:

Amarillo, Texas	Kansas City, Mo.	Oklahoma City, Okla.
Atlanta, Georgia	Knoxville, Tenn.	Omaha, Nebr.
Boston, Mass.	Louisville, Ky.	Philadelphia, Pa.
Brownsville, Texas	Little Rock, Ark.	Pierre, S. D.
Buffalo, N. Y.	Memphis, Tenn.	Pittsburgh, Pa.
Charleston, S. C.	Milwaukee, Wis.	Raleigh, N. C.
Chicago, Ill.	Minneapolis, Minn.	St. Louis, Mo.
Cleveland, Ohio	Moorehead, Minn.	Tampa, Fla.
Dallas, Texas	Mobile, Alabama	Vicksburg, Miss.
Denver, Colo.	New Orleans, La.	Washington, D. C.
Detroit, Mich.	New York City, N. Y.	Wichita, Kans.
Houston, Texas	North Platte, Nebr.	Indianapolis, Ind.

Canadian Stations

Montreal	Ottawa	Toronto
Winnipeg	Port Arthur	

BOOK REVIEWS

PHARMACOLOGY OF THE MEDICINAL AGENTS IN COMMON USE. Eli Lilly & Co. Indianapolis, Ind.

The student of medicine will always find the large standard texts on pharmacology indispensable for critical study of the actions and uses of drugs. These texts, however, are in many instances so voluminous that they are not available for ready reference or for study in spare moments.

Heretofore there has been no comprehensive, small-size work on pharmacology. To meet this need Dr. Stanley Coulter, Dean Emeritus of the Purdue University School of Science, spent over three years in the preparation of a compact treatise on the pharmacology of the drugs now in common use by the medical profession. In this work he had the co-operation of members of the medical and research staffs of the Lilly Laboratories.

The subjects are alphabetically arranged for quick reference. Under each title there is a terse statement of the constituents of the drug, its physiological action, dosage, and brief mention of its more important therapeutic uses.

While this Pharmacology is prepared with special reference to the needs of the medical student it is of hardly less interest or use to the pharmacy student. It is not intended to supplant the "Guide to the Official Organic Drugs," published by the same house, but covers a different field.

The book is supplied in flexible fabricoid binding, 254 pages, 3⅜ by 6 inches, green edges; published by Eli Lilly and Company, Indianapolis; price 50 cents per copy postpaid.

THE JOY OF IGNORANCE. By T. Swann Harding. William Godwin, Inc., New York, 1932.

In 1930 T. Swann Harding published "Fads, Frauds and Physicians." It was an interesting book, a book that made members of the medical and pharmaceutical professions sit up and take notice.

It is true that he has been accused of distorting a picture by giving his audience a "close up" of a small section of it and ignoring the other 99 and 44/100 per cent. But nobody has ever convicted

him of making a misstatement, and he has had a perfectly elegant time quoting writers on medical and pharmaceutical subjects in support of his statements.

He is not a controversialist, he simply states facts and lets you draw your own conclusions, sometimes. If you can find facts which are on the other side of the argument, so much the worse for him, but on the whole his influence has been to make the serenely complacent sit up and take notice.

He is a scientific worker in the field of biological research and he "knows his stuff" when it comes to detecting fallacious conclusions drawn from half-baked premises.

In 1931 he published a second book, called "The Degradation of Science." This book is largely concerned with the evils of the capitalistic control of scientific research. This book is a joy and a stimulus to many who have thought the same thoughts but never could or dared to express them.

The chapter headings from this work will be illuminating. I. Can Trickery Be Professionalized? II. Education in the Hands of the Trader. III. The Dilemma of Our Social Scientists. IV. The Predicament of the Journalist. V. Metaphysicians and Other Lords of Ghostland. VI. Blind Leaders of the Blind. VII. The Law and the Profits. VIII. Extracting the Root of All Evil. IX. The Scientist on the Corner. X. Physician *Heel* Thyself. XI. Science and the Money Minds. XII. Learning More and More About Less and Less. XIII. The Economic Perversion of Idle Curiosity. XIV. The Public Is Served.

His latest book—the title of which is used as the heading of this review, is a joyous book to those who hate bunk, superstition and ignorance.

It is devoted to the "debunking," "unlacing" and "disillusioning" of ADVERTISING.

Every thinking person, every scientist (and even some of the pseudoscientists) have wondered if there was any limit to the misuse of science by the so-called advertising experts.

The controversy between fact and fiction in advertising circles has almost duplicated the famous argument as to "what will happen when an irresistible force meets an immovable body?"

If you want some entertaining reading about the advertising claims for acidophilus; alcohol containing tonics; coffee and coffee substitutes; cigarettes; physical culture; tooth pastes; vitamins;

ultraviolet light; cold cures; eugenics, etc.; by all means get a copy of "The Joy of Ignorance," read it and give or lend it to any of your friends who is intelligent enough to profit by it. The writer of this review has purchased three copies, given away two and is now searching for the third, his own. Perhaps it may be returned before the edition is exhausted. He hopes so.

C. H. L.

KINGZETT'S CHEMICAL ENCYCLOPEDIA. An Epitomized Digest of Chemistry and Its Industrial Applications. By C. T. Kingzett, F. I. C., F. C. S. Fifth Edition. D. Van Nostrand Company, New York, 1932.

The value of a book such as this is its popularity. The popularity of a book is attested by the demand for it. Any book which can achieve a record of five editions in twelve years has earned its place in the reference libraries of the profession which it serves.

Strangely enough, during the past few editions there has been no change in the first or the last items.

It would be difficult to find an important substance to precede "*abietic acid,*" and "zymogens" holds an undisputed place as a final subject.

A curious coincidence is noted in the fact that the third edition and the fifth edition each have exactly the same number of pages.

A careless reviewer would jump at the conclusion that a few places had been cut and a few items changed to justify the claim of a new edition, but in the case of the book in question, this conclusion would be incorrect and unjustified.

The book has been very thoroughly and completely revised. Whole sections have been rewritten and condensed. Many new titles have been added. The book continues to reflect the progress of general and industrial chemistry and is justifying its popularity.

C. H L.